# Ornamental Plants

## Annual Reports and Research Reviews

THE OHIO STATE UNIVERSITY OARDC

THE OHIO STATE UNIVERSITY EXTENSION

January 1997
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Ohio State University Extension
Ohio Agricultural Research and Development Center


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Cover Photo: Plant diagnosticians learn about frost injury on the weeping katsura tree at the 26th Ohio-Indiana Plant Diagnostic Workshop at OARDC's Secrest Arboretum in October.

# Ornamental Plants

## Annual Reports and Research Reviews

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# Teamwork at The Ohio State University: The Extension Nursery, Landscape, and Turf Team

James A. Chatfield, Joseph F. Boggs, Jane A. Martin, Pamela J. Bennett, and Gary Y. Gao

*"The ENLTT has provided a new emphasis and approach from Extension, communicating with all facets of the green industry, for the first time crossing traditional county lines and communicating in a coordinated way between county agents and state specialists in all relevant departments. This has opened up better communication and education on many issues, from IPM to worker protection standards, from business management to better communication between industries."*

— Bill Hendricks, Klyn Nursery, Inc., Painesville, Ohio

What is this ENLTT Bill is talking about?

ENLTT is a group of 24 Ohio State University Extension state specialists, Extension agents, researchers, and teachers. They come from a number of departments, including horticulture and crop science; entomology; plant pathology; from Ohio State University's two-year Agricultural Technical Institute; and from all across the state. First, to better understand ENLTT, a short history lesson is in order.

In 1992, seven key faculty members in the horticulture department of The Ohio State University retired, including Dr. Elton Smith, then the Nursery/Landscape Extension specialist in the department. With these retirements, and with the long-term prospect for continuing budgetary constraints for public funds for horticultural and agricultural Extension in Ohio and the United States, the question was asked: What does Ohio State University Extension have to offer Ohio's nursery and landscape industries?

One answer was that, even with those key retirements, there were still numerous people and resources available within Ohio State University in the Departments of Agronomy, Entomology, Horticulture, and Plant Pathology (Agronomy and Horticulture have since merged into the Department of Horticulture and Crop Science). There were numerous field faculty (Extension agents) of Ohio State University Extension throughout the state. There were faculty at Ohio State University's two-year Agricultural Technical Institute.

These people and resources were not organized, however, as a coordinated team in a recognizable way for the industry to work with them, or

James A. Chatfield, Ohio State University Extension, Northeast District/Horticulture and Crop Science; Joseph F. Boggs, Ohio State University Extension, Hamilton County; Jane A. Martin, Ohio State University Extension, Franklin County; Pamela J. Bennett, Ohio State University Extension, Clark County; Gary Y. Gao, Ohio State University Extension, Clermont County

in terms of their own planning. The Ohio Nurseryman's Association (now Ohio Nursery & Landscape Association — ONLA) President Brian Decker (Decker Nurseries, Groveport, Ohio) was asked: "How would ONLA react if we in Extension got our act together, fostered specialization of agents to better serve the industry at a higher level of expertise, and better planned as an overall Team to provide a cohesive program for the industry?"

Brian Decker's answer then was, "If you do that, it will put the ball into our court." With that impetus, ENLTT was born. The Ohio State people did come together as a planning body, presenting coordinated yearly proposals to ONLA that it has funded generously the past four years, putting the ball back in Ohio State's court. As Brian Decker has since said, "This Team development and specialization is the best thing Extension has done for the industry in Ohio."

With the ball back in Ohio State University's court, in what concrete ways has ENLTT delivered? First of all, it is critical to stress that what ONLA and Ohio State University Extension have bought into, in a major way — starting with ENLTT there are now 18 Extension commodity teams in Ohio, from a Sustainable Agriculture Team to a Swine Team — and what other organizations are buying into (including the Ohio chapter of the International Society of Arboriculture) is not just a direct fee for services rendered.

They went after a bigger bang for the buck — the energy of synergy, the genius of a team that is better than its parts. By encouraging people to work and learn together, through funds for travel to team meetings, for better books and other resources for team members, for better computer capabilities for team members to improve ways of distributing information, funders of ENLTT bought into the future. They bought into team development and the benefits from all that accrues.

However, back to the ever-demanding present. Again, what has ENLTT done for the industry lately?

- Better programs for the industry, from intensive two-day IPM workshops to garden center train-the-trainer sessions for managers.
- A much-improved applied research circular with 5,000 copies for the industry yearly.
- Enhanced coordination at the annual Ohio State University Nursery Short Course.
- Educational materials for ONLA to sell, such as the popular color picture guide, "Insects and Diseases of Ornamental Trees and Shrubs" (over 10,000 sold), which is now available with an accompanying 160-slide set and fact sheet series.
- Better educational articles for ONLA's "The Buckeye" monthly magazine and other publications in Ohio.
- Development of the Buckeye Yard and Garden Line (BYGL).

Without doubt, the development of the Buckeye Yard and Garden Line (BYGL) is the most far-reaching of ENLTT's efforts and the one that best illustrates the benefits of a team orientation such as ENLTT.

What is the BYGL and how do industry funds help make it work?

BYGL is a weekly (April–October) update of landscape plant, pest, disease, and cultural problems. It is developed from a weekly conference call of ENLTTers from throughout the state (ONLA funds help reimburse various offices for long-distance charges). A group of BYGL writers then decides which articles to craft from the conference call each week and to submit via electronic mail to a weekly sender. (ONLA funds helped pay for computers and modems for writers.) The sender and a proofreader, communicating by electronic mail, then produce a final BYGL within 48 hours of the weekly call.

From extensive surveys of BYGL users, the keys to its usefulness are the timeliness, the short length of BYGL items (one to two paragraphs), the fact that it helps with current problem diagnosis, and the interspicing with humor.

The BYGL is then sent to all county offices in Ohio (and some neighboring states) by elec-

tronic mail. It is sent to a list of hundreds of electronic mail addresses throughout the United States. It is sent by FAX subscription to green industry companies in Ohio that do not have electronic mail. Now, in 1995–96, BYGL is "networthy" with sites on Ohio State University's Horticulture in Virtual Perspective's Web-Garden server, on PenPages, and on the Ohio Department of Natural Resources Division of Forestry Web home page.

On Webgarden, Buckeye Yard and Garden onLine not only is archived for reference to past editions but also is complemented by color slide images which accompany BYGL articles, with additional links to Ohio State University Extension factsheets. This is only the beginning, as are other innovations such as BYGLive! sessions, which are weekly arboretum diagnostic walks throughout the state that feed industry observations into each week's BYGLs.

How do people use BYGL? Here are a few comments from industry and other users:

"The BYGL is the best, most informative, timely publication I receive. It is absolutely the only resource that is written in a manner everyone can understand, and its length is about enough that everyone reads it. I send it to branch facilitators who put it on the bulletin board. Specialists read it and relay it to customers. It definitely helps to substantiate training materials."

— Bob Avenius, TruGreen-Chemlawn, Indiana and Ohio branches

"I have kept a collection of the last three years of info. I review the current info and am well-prepared to answer questions from the public. The latest BYGL, a cup of coffee, it doesn't get much better than this."

— Alan Siewert, Ohio Department of Natural Resources, Urban Forester

"A great tool to identify problems before they arise in our area. With the state split into three areas, we can anticipate problems/solutions by watching what is happening in the southern part of the state. Very helpful for our Garden Center. Gives us time to train our people for these situations and update our own database when treatments and conditions change."

— Peter Scarff, Scarff's Nursery, Springfield, Ohio

Other short comments from BYGL users:

"We copied and gave a copy to each of our foremen to help them identify problems and field questions from clients and improve their knowledge."

"Has changed some of our tree maintenance practices."

"Best use of government money going."

"An example for starting a Wisconsin Urban Hort Update from our weekly teleconferences."

"BYGL is shared with the plant inspectors, entomologists, and plant pathologists at the Pennsylvania Department of Agriculture."

"We put it on the counter for all our customers to read."

"Information used to reinforce product recommendations to customers."

"It helped to confirm problems I saw, offered solutions that worked, and tipped me off to problems before they were apparent."

"Several clients commented that they needed the information on the very day that the BYGL arrived."

So, what is the message in all this? To be sure, OSU Extension would help the industry the best they could without financial support, and without ENLTT for that matter. However, with the Team and its industry partnerships, Extension is doing things it never could have done with everyone working in isolation. There is something else to remember about a good team; it is important not to sublimate team initiative and individual specializations and skills. Team members have a term, "teamjazz," that speaks to this dynamic equilibrium between the individual and the team. So, to close, here are two

favorite ENLTT quotes, one from the jazz critic Stanley Crouch and one from the ENLTT mission and vision statement.

"The high degree of individuality together with the mutual respect and cooperation required in a jazz ensemble carry with them philosophical implications that are so exciting and far-reaching that one almost hesitates to contemplate them. It is as if jazz were saying to us that not only is far greater individuality possible to man than he has so far allowed himself, but that such individuality, far from being a threat to a co-operative social structure, can actually enhance society."

— Stanley Crouch

Productive teams are like a good jazz ensemble; everyone has his/her own instrument to play, and creativity and virtuosity are strengths, but creative interplay heightens the effect. Then, the second synergy really kicks in through industry partnerships.

From the ENLTT vision and mission statements:

"The mission of the OSU Extension Nursery, Landscape, and Turf Team, through our interdisciplinary and industry partnerships, is to improve the process of development, acquisition, delivery, and support of accurate, practical, and timely educational resources. The vision of ENLTT is to serve as the University's partner with the green industry to position us for the future."

In Ohio, and throughout the United States, Extension and the green industry, working together, are quite a Team.

—•—

# Extension Nursery, Landscape, and Turf Team Directory: 1997

## Our Vision

The vision of the Extension Nursery, Landscape, and Turf Team is to serve as the University's partner with the green industry to position us for the future.

## Our Mission

The mission of the Extension Nursery, Landscape, and Turf Team, through our interdisciplinary and industry partnerships, is to improve the process of acquisition, delivery, and support of accurate, practical, and timely educational resources.


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# Floriculture Industry Roundtable of Ohio: 1997

## Our Mission

The mission of the Floriculture Industry Roundtable of Ohio is to provide an educational forum to Extension, growers, and allied industries across the Midwest region currently including Ohio, Michigan, Pennsylvania, Kentucky, and Indiana for the exchange, discussion, and dissemination of information related to floriculture.

## Roundtable Resources and Team Members

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# Ohio Deciduous Tree Evaluation Project: A Proposal

## The Project Team

The proposal for this project was developed by an interdisciplinary team interested in evaluating deciduous trees for Ohio environments. This team includes, but is not limited to:

**Ken Cochran**
The Ohio State University Agricultural Technical Institute, and Curator, Secrest Arboretum of the Ohio Agricultural Research and Development Center

**Pam Bennett**
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**Jim Chatfield**
Ohio State University Extension, Northeast District and Department of Horticulture and Crop Science

**Jack Kerrigan**
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**Jane Martin**
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**Dave Shetlar**
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**Alan Siewert**
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**Randy Zondag**
Ohio State University Extension, Lake County

## Materials and Methods

The proposal involves the redevelopment of the Shade Tree Evaluation Plot at Secrest Arboretum. This plot has reached and passed its maturity, exceeding plant spacing provided by the original plot design. The project would involve removal and selective transplanting of existing trees, and development of a new replicated plot for evaluating plants for selected horticultural, adaptability, and pest and disease characteristics.

The plot would include four separate sub-plots, each of which would contain multiple replicates of trees in randomized complete-block designs. The four proposed sub-plots would focus on:

- Species and their cultivars in the genus *Acer* (maple)
- Species and their cultivars in the genus *Fraxinus* (ash)
- Species in the genus *Quercus* with the intention of investigation of new propagation approaches
- A diversity plot of additional species of interest to the green industry.

Data and observations from evaluation sub-

teams will be gathered several times yearly. Results will be regularly published in multiple forums, including OARDC circulars. Field days will be scheduled regularly for the green industry and the public at large.

## Timetable

Renovation of this plot is proposed to begin in 1997. The projected longevity of the plot is 20 years from the end of the renovation process, which is projected to take three to five years. A field day is scheduled for March 3–4, 1997, to start needed removal of declining older trees, to transplant some of the smaller trees from the original project, and to initiate stump removal studies and pruning demonstration sites.

## Location

The proposed project would be located at the Secrest Arboretum of the Ohio Agricultural Research and Development Center of The Ohio State University in Wooster, Ohio, at the current site of the Shade Tree Evaluation Plot on Williams Drive.

## Rationale

Proper plant selection is the cornerstone of landscape horticulture, urban forestry, and arboriculture. Evaluating plants for their establishment, growth and development, and stress tolerance characteristics as well as pest and disease resistance attributes is the all-important first step to responsible plant stewardship. Proper plant selection results in lower maintenance costs, less frequent replacements, and lower pesticide usage.

For more information on the Deciduous Tree Project, contact:
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# Environmental and Cultural Problems of Ornamental Plants in Ohio: 1996

Pamela J. Bennett and Jane C. Martin

## Summary

April and May of 1996 were the wettest on record for Ohio, since records began in 1882. The cool and very wet spring delayed normal plant development by about 10–14 days. Unusually low temperatures and scattered frosts were reported from around the state on May 12 and 13. These frosts damaged some early-planted annuals and new growth on woody plants.

Salt injury symptoms on evergreens were especially evident this spring on plants located near highways. This was attributed to the heavier use of road salt during the winter to melt heavy snowfall.

Several species of plants exhibited abnormal foliage color during the summer, including pale-green foliage, physiological scorch symptoms, and early fall coloration. Limited root development during the wet spring may have contributed to these problems.

Reports of "toxic" mulch damaging plants were numerous this season and related to excessive spring moisture. As mulch ferments under anaerobic conditions, chemicals are produced that can be toxic to plants.

## Introduction

Extension agents, specialists, and a few others in the industry hold a weekly conference call during the growing season. Information on current weather conditions, pest problems, cultural problems, and other topics that relate to ornamental plants are discussed, summarized, and then distributed. This is an effort to keep members of the green industry, Extension personnel, and others apprised of problems occurring in landscapes.

Included here is a compilation of Ohio weather conditions and noteworthy environmentally induced and cultural plant problems in 1996. Observations are drawn from information provided in Ohio State University Extension's *Buckeye Yard and Garden Line* and from the *Ohio Department of Natural Resources Monthly Water Inventory Report.*

## Discussion

### Weather Background

April rainfall was heavy across the state. At the end of April, the Ohio Agricultural Statistics Service reported that soil moisture was at "surplus" for 90% of the state. This was beneficial for water supplies, but caused moderate flooding and greatly delayed planting activity.

Rain continued in May; in many areas, it rained more than 20 days. Flooding increased in many areas. In the last 10 days of May, northern Ohio began to dry out, though rain continued in southern Ohio.

In the two months of April and May, many locations received one-half to one-third of normal total precipitation for the year. By the end of May, Dayton was +12.4", Cincinnati +11.7", Columbus +7.4", Mansfield +10.7", Akron +4.2", and Cleveland +1.3". Also in this period, temperatures remained cooler than normal, and cloud cover was significant.

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Rain continued into June; however, the second half of the month began to dry out. The drying trend continued into July; some parts of the state had no rain during the first two weeks, and lawns began to show signs of stress/dormancy. In mid-July, a few storms crossed Ohio, delivering adequate moisture to re-green browning turf in many locations.

August was dry with only scattered rainfall across most of the state. West-central Ohio reported virtually no rain. Lawns were dormant in many locations, and recommendations to irrigate lawns and new ornamental plantings were given. Many locations reported soil moisture deficits at the end of the month.

During the first week of September, Hurricane Fran delivered rainfall, varying from +5" in the eastern and northern regions of Ohio, to only a quarter inch in west-central Ohio. Scattered storms continued across Ohio through the month. At month's end, Cuyahoga County reported the wettest month ever on record, with over 10" of rainfall; Lorain County reported just over 11" for the month.

## A Late Spring

Roller coaster weather in April led to a "late" spring. Hail; rain; tornadoes; alternating mild, sunny days; and cold, snowy days were all reported. Ornamentals such as Callery pear, early crabapples, and cherries were blooming side-by-side in the Cincinnati area, an unusual occurrence. The cool, wet spring delayed normal development of many plants and insects by 10–14 days.

On May 12 and 13, temperatures were in the low 30°Fs throughout most of the state, with record lows reported in Cincinnati and Columbus. Scattered light frosts were reported. Damage was most severe to early planted annuals and those on display in garden centers. Hostas were damaged in several locations, as well as tender, new growth of some ornamentals. Frosted new growth on *Taxus* spp., which appeared curled and brown, was commonly seen and commonly misdiagnosed as growth-regulator herbicide injury.

## Plant Injury

Little winter injury was reported on ornamental plants, with the exception of ornamental grasses. Many grasses were slow to emerge in the spring, particularly fountain grass (*Pennisetum alopecuroides*). Many plants had dead centers or limited growth on the perimeter of the clump.

## Cultural and Planting Problems

Injury attributed to road salt spray was particularly evident on conifers along the highways and byways of Ohio this spring, and reports continued through May. The salt used to treat icy roads became airborne and affected plants 100 to 150 feet from highways, depending on the force and direction of the winter wind. Salt damage on evergreens tends to appear in late winter and worsens in early spring.

Needles turn progressively brown from the tips towards their base. Damage to deciduous plants was not apparent until bud break, when bud and branch dieback was noticed. Classic symptoms of airborne salt injury appear on one side of the plant, the side facing the salted highway. However, this year, whole-plant injury of trees along highways occurred, perhaps due to heavier use of highway salt combined with winter desiccation.

Injury from airborne salt spray is caused primarily by cell and tissue sensitivity to the chloride ion. Chloride moves in the transpiration stream to leaf tips and margins and may accumulate there in toxic concentrations. Salt injury from salt runoff into soil is more complex. Toxic accumulation of ions in plant tissues may occur, but salts also increase the osmotic potential of the soil solution, which can severely impair the ability of roots to absorb water and nutrients. Roots, in essence, experience drought in high salt soils, even when moisture is available.

Plants reported in the literature to be sensitive to salt injury include azalea and rhododendron, beech, river birch, boxwood, black cherry, cornelian cherry, cotoneaster, crabapple, dogwood, Douglas-fir, white fir, sweet gum, forsythia, hemlock, hickory, American holly, com-

mon lilac, red and sugar maple, eastern white pine, flowering plums, flowering quince, Allegheny serviceberry, white spruce, sycamore, tulip tree, and yew.

## Seasonal Stress Observations

With the record spring rainfall, limited plant root development occurred. By mid-June, plants such as birch, maple, some viburnums, winged euonymus, and several others were exhibiting light-green foliage. In July, during the dry spell, plants began to show additional symptoms of stress, including physiological leaf scorch and early fall coloration. Plants such as flowering dogwood, oaks, tuliptree, and several species of maples exhibited leaf scorch. River birch, European white birch, burning bush, callery pear, flowering dogwood, and red maple showed early fall coloration.

## Problems with Mulch

Reports of chlorotic, scorched, or dying bedding plants attributed to "toxic mulch" occur every year, and excessively wet conditions this year increased the number of reports. Organic mulches can undergo anaerobic (without oxygen) fermentation when stored for extended periods in piles greater than six to eight feet in height. The chemicals produced by fermenting organisms can be quite toxic to plants. Small annual plants were severely damaged or killed outright by toxic fumes or direct contact with the mulch; perennial plants exhibited leaf chlorosis and defoliation. Woody ornamental plants with low-growing branches close to the mulch can also be damaged.

Fortunately, "toxic mulch syndrome" is quite easy to diagnose and prevent. Mulch that has gone anaerobic will have a very strong, acrid, sour odor. In contrast, mulch that is safe to use will have a pleasant, musky smell, like freshly cut wood or compost.

Mulch handlers can prevent the problem by turning mulch piles frequently to prevent anaerobic conditions and by maintaining piles under six to eight feet in height. Mulch stored in plastic bags is not immune to this problem, especially if water gets into the bags. Bagged mulch should be stored on wooden pallets with room for air flow. Anaerobic mulch can be used if leached heavily with water to remove harmful toxins and if aerated for several weeks.

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# Insect and Mite Activity Noted in Ohio: 1996

Joseph F. Boggs, David J. Shetlar, Jane A. Martin, Pamela J. Bennett, James A. Chatfield, Daniel R. Balser, and Gary Y. Gao

## Summary

Insect and mite activities reported in the Ohio State University Extension's Buckeye Yard & Garden Line (BYGL) and Pest Evaluation and Supression Techniques (PEST) newsletter are summarized and compared to previous seasons. A cool and rainy spring caused significant changes in pest activity. Special discussions of caterpillars, sawflies, weevils, white grubs, lace bugs, scales, and mites are presented. Unusual insect and mite activity is also reported.

## Discussion

### Weather: Effects on Insects and Mites

Several reports made in both the BYGL and the PEST emphasized the significant effects this season's weather had on insect and mite developmental rates, pest population levels, and pest/host relationships. Heavy spring rains and/or extended cool temperatures and a midsummer mini drought were reported as having a meaningful impact on European earwigs (*Forficula auricularia*), yellow jackets (*Vespula* spp.), hairy chinch bugs (*Blissus leucopterus hirtus*), bluegrass billbugs (*Sphenophorus parvulus*), black turfgrass ataenius (*Ataenius spretulus*), sod webworm (Lepidoptera: Pyralidae: Crambinae), bagworms (*Thyridopteryx ephemeraeformis*), aphids (Homoptera: Aphididae), spruce spider mite (*Oligonychus ununguis*), two-spotted spider mites (*Tetranychus urticae*), and white grubs (Coleoptera: Scarabaeidae).

**Spring Rains** A record breaking wet spring throughout much of Ohio provided favorable conditions for some pests, but limited population development of others. For example, the following appeared in BYGL 96-11 (June 13): "The continual wet weather is producing a bumper crop of earwigs. Extension offices are being deluged by homeowner horror stories spawned by the frightful appearance of these nocturnal creatures and their repugnant habit of emitting a foul-smelling, yellowish-brown liquid from their scent glands when disturbed."

The wet weather proved less congenial for other insects and for some mites. In BYGL 96-5 (May 2), BYGLers theorized that the heavy April rainfall may have had a deleterious effect by drowning certain turfgrass insect pests such as white grubs, chinch bugs, billbugs, and sod webworms. However, Dave Shetlar noted that the ultimate impact of the heavy rainfall on insect populations could only be speculated, and that it probably would not be enough to limit population rebound.

The pernicious effects of the wet spring were not limited to turf insects. In BYGL 96-10 (June 6), Dave Shetlar reported that heavy spring rains have reduced populations in central Ohio of spruce spider mites, first instar bagworms, and several species of aphids.

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Wet weather did indeed cause the population pendulum to swing back and forth for various species of aphids. As noted above, aphid populations appeared to be suppressed by heavy rains for the first part of the season — the aphids were simply washed from the plants. However, as conditions became drier during July and August, aphid populations recovered.

Yellow jacket populations appeared to remain relatively low throughout the season over most of Ohio. In BYGL 96-20 (August 15), BYGL participants speculated that heavy spring rainfall may have drowned yellow jacket queens as they attempted to construct nests below ground. In addition, unseasonably cool temperatures this summer may have slowed nest expansion and delayed development. Yellow jacket populations did tend to rise toward the end of the season. Of course, the highest seasonal population densities for yellow jackets are normally observed from mid-August into October.

**Cool Temperatures** Coupled with heavy rainfall, unseasonably cool temperatures also occurred throughout much of Ohio from April through late June. July and August also had below normal temperatures except for a few short days of temperatures in the 90°F range. As was already discussed relative to yellowjackets, the cool temperatures appeared to have a notable influence on delaying insect development.

For example, in BYGL 96-7 (May 16), Vanhoutte and bridal wreath spiraea, as well as horsechestnut, were reported to be blooming in southwest Ohio. These phenological observations normally coincide with movement of black turfgrass ataenius adults from overwintering sites (e.g., under leaves in woods) to egg-laying sites such as turf on golf courses. However, PEST 5:5 (May 13) indicated that "This year, this activity [movement of ataenius to oviposition sites] has been greatly delayed."

Other insects, such as bluegrass billbug, were also slow in making an appearance. Normally, adults go on a walkabout searching for egg-laying sites from late-April to mid-May. However, ovipositing bluegrass billbugs were not observed in central Ohio until mid-June (BYGL 96-11, June 13).

## Sawflies

Given that 1993 was tagged "the year of the sawflies" (1), 1996 could very well be called "the year of the sawflies, part two." These wasp-related insects were a significant part of the landscape this season. The usual suspects such as the early season European pine sawfly (*Neodiprion sertifer*), the introduced pine sawfly (*Diprion similis*), azalea sawfly (*Amauronematus azaleae*), dogwood sawfly (*Macremphytus tarsatus*), and the late-season white pine sawfly (*Neodiprion pinetum*) were joined this year by some unusual suspects. These included the maple petiole borer (*Caulocampus acericaulis*), the willow/poplar sawfly (*Trichiocampus viminalis*), and the dusky birch sawfly (*Croesus latitarsus*).

When reported in previous years' BYGL and PEST, the maple petiole borer was most noticeable in central and northeastern Ohio. Conspicuous damage this season was located in southwest Ohio (BYGL 96-9, May 30). The small larvae burrow inside the petiole, causing leaf bases to turn brownish-black, droop, and then drop from the tree. Larvae remain inside the petiole attached to the twig, so raking and destroying fallen leaves will not reduce the population.

Willow/poplar sawflies are black or greenish-black with conspicuous yellow spots on the sides. Larvae feed in colonies, eventually consuming entire leaves and more than one generation may occur in Ohio. Heavy damage was reported in BYGL 96-22 (August 29).

The dusky birch sawfly also feeds gregariously. Heavy infestations on gray birch in southwest Ohio were reported in BYGL 96-25 (September 19). Early instars have shiny black head capsules and yellowish-green bodies. Later instars have distinct rows of black spots. Larvae consume all but the large lateral veins and midvein.

## Caterpillars

Numerous species of caterpillars were reported in 1996; however, with the exception of gypsy

moth (*Lymantria dispar*) and the mimosa webworm (*Homadaula anisocentra*), no major outbreaks were reported. Common spring caterpillars such as eastern tent caterpillar (*Malacosoma americanum*), spring cankerworm (*Paleacrita vernata*), and forest tent caterpillar (*Malacosoma disstria*) made widespread but moderate appearances. Eastern tent caterpillars hatched in early to mid-April (PEST, April 15), and spring cankerworms were observed at the end of the month.

Forest tent caterpillar feeds on oak as well as blackgum, sweetgum, water tupelo, and quaking aspen. The larvae may appear on trees at the same time as gypsy moth and eastern tent caterpillars. The overlapping time-frame caused identification confusion for some Extension clientele (BYGL 96-15, July 11).

Although the forest tent caterpillar is called a tent caterpillar, larvae construct only rudimentary mat-like nests near the ends of branches rather than tents in branch forks or crotches like the eastern tent caterpillar. Also, forest tent caterpillars have distinct "keyhole-shaped" markings running down their backs rather than the solid white line found on eastern tent caterpillars. Late instar gypsy moth larvae have colored spots — five pairs of blue spots followed by six pairs of red spots — running down their backs.

The high gypsy moth populations and defoliation projected for the northeastern and east-central counties did not generally materialize because the larvae were commonly infected with fungal diseases. Populations around Toledo continued to expand, and activity in this area will cause considerable public concern over the next few years.

Summer/fall caterpillars such as yellow-necked caterpillar (*Datana ministra*), hickory tussock moth (*Lophocampa caryae*), catalpa sphinx (*Ceratomia catalpae*), and fall webworm (*Hyphantria cunea*) were also reported in localized areas across Ohio. Although called "fall" webworm, larvae of this moth were reported in early August (BYGL 96-19, August 8), not unusual for Ohio.

As with previous years, mimosa webworm was observed causing considerable damage to honeylocust in several areas of the state (1, 3). Since at least two generations occur per year and larvae continue to feed until first frost, early control of this insect is essential to avoiding heavy damage. Early instars are easier to control (later instars are shrouded in webbing); however, since adults lay eggs over an extended period of time, two applications, 10–14 days apart, are recommended. The second application will kill new larvae hatching from the pearly, bright-pink eggs.

## Weevils

Owing to its broad host range of more than 100 plants, black vine weevil (*Otiorhynchus sulcatus*) remained one of the most commonly reported insects in Ohio. However, other important weevils were observed and reported in 1996. These included the white pine weevil (*Pissodes strobi*), the yellow poplar weevil (*Odontopus calceatus*), and the Japanese weevil (*Callirhopalus bifasciatus*).

White pine weevils received little attention in previous BYGLs due primarily to its distribution in Ohio. It is seldom seen in the central or western parts of the state. However, in eastern Ohio woodlands the insect often achieves major pest status, particularly in Christmas tree plantations. Although white pine weevil is the common name generally used for this insect, the weevil also has two other recognized common names — the Engelmann and Sitka spruce weevils. These common names illustrate the point that this weevil will feed and breed on spruces as well as white pine. It will also do the same on other pines and Douglas fir. For example, in BYGL 96-13 (June 27), the characteristic "shepherd's crooks" produced by white pine weevil larvae tunneling down terminal shoots were reported to have been observed on Douglas fir in southwest Ohio.

Yellow poplar weevil damage to leaves of magnolia, tuliptree, and sassafras was reported to be severe in 1993 (1). Since that time, BYGLers have closely monitored these trees for the bean-shaped holes cut in leaves by the

adults and for the blotch mines produced by the larvae. However, populations remained low this season as they did in 1994 (2).

Black vine weevil adult emergence was delayed this year, presumably because of the unseasonably cool spring and early summer temperatures experienced throughout much of Ohio. The June 10 PEST noted: "In the landscape, we normally find a few adult weevils by the last week of May. We haven't seen any sign of notching and no weevils have fallen into my pitfall traps — yet." Black vine weevil notching did appear later in the season.

However, observers in northeast Ohio found that not all notching is produced by the black vine weevil. The relatively small (about 1/4 inch) Japanese weevil — a newcomer to BYGL participants (and possibly a new state record) — produces leaf notches which appear very similar to black vine weevil.

## White Grubs

White grub reports this season varied somewhat from observations made in previous years (1, 2, 3). First, imidacloprid became available for use by home owners (e.g., GrubEx ), and its early application timing for grub control caused some confusion in the retail market. Second, owing to this season's unusual weather, overall grub activity was difficult to predict.

Five reports on imidacloprid aimed at explaining the compound's application timing were made in the BYGL and two in the PEST. A report made in BYGL 96-19 (August 8) regarding white grub control was typical: "In previous BYGLs, we reported that this product [imidacloprid] should be applied 30 days prior to grub emergence for best results. Dave [Shetlar] noted that there is still time to apply this product for grub control; however, the window closes around August 15th."

"At this time, 80% of grubs are either in the egg or first instar stage. Imidacloprid applied before August 15th and watered in thoroughly will provide control. If it is applied during the third or fourth week of August, Dave suspects the results will drop from 90–95% efficacy to 70–90%. By the time the grubs reach the third instar, the efficacy drops to 50–70%."

Cool and wet spring weather and summer mini droughts caused white grub population predictions to fluctuate widely in 1996. Some predicted that the heavy spring rains could suppress beetle populations by reducing grub numbers. However, observations of spring grub numbers, which remained relatively stable, did not seem to support the "death by drowning" conjecture.

When Japanese beetle (*Popillia japonica*) adults appeared in late-June to early-July, overall adult activity appeared to be unusually low for that time of year (PEST, July 8). Since grub numbers had not appeared to be suppressed, it was speculated that unusual spring and summer weather in 1995 coupled with 1996 heavy spring rains produced an extended adult emergence (3). Thus, it was predicted that rather than a having a large surge of adults, there would be a slow trickle, and feeding as well as oviposition would extend over an unusually prolonged period of time. This prediction was supported by observations of adult Japanese beetles feeding well into August in some parts of the state.

Based on those observations and follow-up reports of grubs appearing to be developing normally in late-August to early-September, predictions were made that Ohio would experience a "banner" grub year. However, as of late-September, reports of significant grub damage had still not yet materialized. Grub sampling in early October indicated that Japanese beetle grubs were, indeed, slow to develop with many second and early third instar grubs present. On the other hand the masked chafers (*Cyclocephala* spp.) had developed normally, but their populations were greatly reduced, possibly because of the mini drought in late June and early July.

## Lace Bugs

In 1995, heavy spring rains caused lace bug populations to develop slowly; however, once

rains subsided, lace bug numbers climbed quickly to damaging levels (3). In 1996, early heavy rains seemed to have little effect on lace bug populations, especially in the southern half of Ohio.

By late May, azalea lace bugs (*Stephanitis pyriodes*), hawthorn lace bugs (*Corythucha cydoniae*), and a buckeye lace bug (*C. aesculi*) were reported to be causing their characteristic yellow stippling to the upper surface of their host's leaves. In early June, damaging population levels of oak lace bugs (*C. arcuata*) were observed on burr oak in southwest Ohio and other white oaks in northern Ohio through the rest of the summer. Damage reports from these lace bugs continued throughout the season.

In late September, heavy infestations of lace bugs caused severe damage to black cherry in Harrison County, Ohio. Although a positive identification was not obtained, there are two lace bug species that feed on black cherry — the cherry lace bug, *C. pruni,* and *C. associata.*

## Scale Insects

The most commonly reported armored scales in the BYGL and the PEST included pine needle scale (*Chionaspis pinifoliae*), euonymus scale (*Unaspis euonymi*), and oystershell scale (*Lepidosaphes ulmi*). Common soft scales included cottony maple scale (*Pulvinaria innumerabilis*), European fruit lecanium (*Lecanium corni*), terrapin scale (*L. nigrofasciatum*), tuliptree scale (*Toumeyella liriodendri*), and magnolia scale (*Neolecanium cornuparvum*).

Crawler stages for these scales appeared on schedule this season with two exceptions. By late May, the rusty-red colored pine needle scale crawlers and the yellowish-cream colored euonymus scale crawlers had been observed in southwest Ohio and in West Lafayette, Indiana. However, in Columbus, the euonymus scales had not laid eggs, and the pine needle scale crawlers had not yet appeared. Although the exact explanation for the variation is not known, speculation was that small differences in locations and hosts, not major differences in weather, accounted for the observed disparity in developmental rates (PEST, May 28).

## Mites

As in 1995, large numbers of spruce spider mites *(Oligonychus ununguis)* were washed from their hosts by the heavy spring rains in 1996 (3). Populations rebounded quickly in late June to early July due to the relatively cool summer temperatures. Normally, this cool-season mite shuts down in early July, once temperatures rise into the mid-to-upper 80s, and doesn't reappear until mid-September. However, in early August, abundant adults and nymphs on spruces and junipers indicated that the mites never went dormant during the 1996 summer.

Two-spotted spider mite *(Tetranychus urticae),* a warm-season mite, was very common in mid June through August on several landscape plants. Because this mite resides on the underside of leaves, it was unaffected by early rains. Two-spotted spider mite was also reported on geraniums in an interior plantscape. This is unusual since geraniol oil, which gives geraniums their characteristic scent, has miticidal activity. However, the infested geraniums were "unscented." As Shetlar stated in PEST (August 5), "no odor, no geraniol, no spider mite protection!"

The oak spider mite (*Oligonychus bicolor*) was also common across Ohio, causing a general bronzing of oak foliage. In the past this pest has appeared to be most common on white oaks but damage was noticed on red oaks in 1996.

The most unusual mite "event" this year was a species of *Tetranychus* that resulted in ash trees "wrapped in cellophane" in late August and early September. Specimens sent to Rayanne Lehman (Pennsylvania Department of Agriculture) were tentatively identified as *T. schoeni.* However, as Lehman stated, out of the 1,000 some specimens sent, there were no males present. The males are necessary for accurate species identification. Since the first report of this mite, similar reports have been received from Indiana, Illinois, Iowa, and Wisconsin.

## Unusual Sightings

Several insects were reported in the BYGL and PEST which could be categorized as unusual.

Either they have not been commonly seen before or they are not widely distributed throughout Ohio. These include the yucca plant bug (*Halticotoma valida*), cypress gall midge (*Itonidae taxodii*), and the apple-and-thorn skeletonizer (*Anthophila pariana*).

A heavy infestation of yucca plant bug was observed on Adam's needle yucca in southwest Ohio. This insect is common throughout the native range of yucca and is following its host plant into other areas of the country. The small (3/16 inch long) oval plant bugs have black wings or wing pads (immatures) and orange-red legs, head, thorax, and abdomen. Feeding produces small white spots (stippling) which coalesce, causing the foliage to appear light green to yellow.

Cypress leaf gall midge made its yearly appearance on bald cypress in southwest Ohio. This insect has been reported in the BYGL in previous years; however, all reports have centered on the southern part of the state. Sizes of the galls vary, ranging from 1/8 to 1.0-inches in length. Although produced by a midge, the cone-like white to bluish-green galls look like a miniature version of the growths produced by the Cooley spruce gall adelgid on Colorado blue spruce.

Like the Cooley galls, the midge galls are covered with a whitish powdery material and occur at or near the tips of the new growth. However, unlike the Cooley galls, the cypress galls are spongy, not woody, and sparsely covered with flexible needles. Also, the midge galls fall apart and disappear in the fall. The life cycle of the midge is poorly documented so no controls are currently available. Although not considered significant relative to plant health, the galls may diminish the plants' aesthetics.

The apple-and-thorn skeletonizer was reported in northeast Ohio as causing significant injury to certain crabapple cultivars in the crabapple plots at the Ohio State University/Ohio Agricultural Research and Development Center in Wooster, Ohio. Larvae of this relatively small moth (adults have a half-inch wingspan) feed mostly on the leaves of apples, pear, and hawthorn. They also attack mountain ash, birch, willow, plum, and sour cherry.

Early instar larvae skeletonize the undersurface of leaves under loose webs. Later instars move to the upper surfaces and draw the opposite sides of leaves together with silk. These structures look like "canoes." Larvae feed inside the fold, consuming everything except the lower epidermis and larger veins. Leaves curl, turn brown, and eventually drop. From a distance, damage appears similar to that produced by Japanese beetles, particularly when old webbing degrades, releasing the folded leaves. There are three and possibly four generations per year, so trees should be monitored closely. Although reported on apples in orchards, the insect seldom achieves damaging levels owing to multiple pesticide applications usually included in orchard management programs.

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# Summary of Ornamental Diseases in Ohio: 1996

James A. Chatfield, Nancy J. Taylor, Stephen N. Nameth, Joseph F. Boggs, and Jane A. Martin

## Summary

This article is drawn from reports in the Buckeye Yard and Garden Line throughout the year, diagnoses in the Ohio State University Plant and Pest Diagnostic Clinic (PPDC), and other observations in Ohio in 1996. A number of diseases were especially severe in springtime due to extended early wet, cool conditions.

## Discussion

**Botrytis Diseases (*Botrytis cinerea, Botrytis* spp.).** Botrytis grey mold disease on many hosts was a major problem this spring due to the extended wet weather. It was a problem in the greenhouse and in landscape plantings. *Botrytis tulipa* was found on tulips. *Botrytis elliptica,* an uncommon species, was found on Asiatic garden lilies in the spring of 1996.

**Bacterial Blight of Lilac (*Pseudomonas syringae* pv. *syringae*).** This disease was frequently reported this year, during extended wet, cool conditions in spring as new growth developed on lilacs. Infections resulted in blackened leaves, stems, and blooms. When lesions girdled succulent shoots, the branch end or flower cluster wilted. Fortunately, lesions rarely develop on woody stems, so dieback of major branches did not typcially occur, and plants generally recovered, even though the disease was more severe than usual in 1996. It is also believed that this same bacterium was involved in a bacterial blight in magnolia this spring in Ohio.

**Peach Leaf Curl (*Taphrina deformans*).** This fungal disease was common in the cool, wet spring of 1996 that followed a mild winter. Developing leaves become severely distorted (thickened and puckered) and have a reddish or purple cast. Later, as spores form on the leaf surface, the leaves become powdery gray in color. Those leaves will shortly turn yellow and drop.

If leaf curl does result in significant defoliation in the spring, the fruit on affected trees should be thinned to compensate for the loss of leaves. A single fungicide application (thoroughly covering the tree), after leaves drop in the fall or before buds swell in spring, will provide adequate control.

**Phytophthora Root and Crown Rots (*Phytophthora* spp.).** These diseases occurred in a number of sites with poor drainage conditions. Some common hosts included rhododendron, brambles, chrysanthemum, peony, snapdragon, and lilac. On lilac, Phytophthora root rot and Phytophthora stem dieback resulted in pale leaf coloration, branch dieback, and plant death. On chrysanthemum, samples exhibited a common symptom of many Phytophthora diseases — black discoloration of lower stem tissue up to the first set of leaves.

**Diplodia (Sphaeropsis) Tip Blight of Pine (*Sphaeopsis sapinea*).** Symptoms developed early on Austrian and Scotch pine samples with new growth discolored and drooping over from this spring's *Diplodia* infections. Tiny black,

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pimple-like fungal fruiting bodies breaking through the needle surface (especially noticeable if you pull back needle sheaths) are a good diagnostic clue for this disease. In some cases, there was subsequent decline of the tree from death of new growth each year. In other cases, especially in some Christmas tree plantations, infections caused canker development further back on the branch and part way down the new candle growth, resulting in the eventual collapse of new candles in the upper part of the tree.

**Anthracnose Diseases (*Discula* spp., *Gloeosporium* spp.).** A number of different anthracnose diseases were reported in 1996, with greatest severity noted on ash and on planetrees, especially sycamore. Other reports were on dogwood, maple, oak, hickory, beech (only the second Ohio report for beech anthracnose), and on unusual hosts such as spiderwort and hornbeam. On hornbeam, symptoms were not the classic blotchiness associated with major veins of leaves as seen with many anthracnose diseases, but rather a diffuse scorching that is very difficult to distinguish from non-infectious physiological leaf scorch.

**Crabapple Diseases.** Though early extended wet conditions in the spring resulted in concern that it would be a bad apple scab (*Venturia inaequalis*) year, scab incidence was close to the average for the past four years in one carefully monitored location — Secrest Arboretum in Wooster. Frogeye leaf spot (*Botryosphaeria obtusa*) was considerably more severe than in most years, with significant defoliation occurring on several cultivars. Incidence of fireblight (*Erwinia amylovora*) varied widely, as was also the case in many apple orchards. Side-by-side orchards often varied from heavy fireblight to light fireblight for reasons that did not seem to be due to past incidence, control strategies, susceptibility of cultivars, or environmental differences.

**Black Root Rot (*Thielaviopsis basicola*).** There were several reports of black root rot on blue hollies (Meserve hybrids). This disease causes stunting, foliar discoloration, and twig dieback from the death of fine roots. Black root rot also results in characteristic black root lesions which are visible if affected roots are washed. Over the past several years, this disease was diagnosed on blue hollies (Meserve hybrids) in both nursery and landscape situations in Ohio. The PPDC has also found black root rot on a number of other plants including petunia, snapdragon, and in past years on verbena, impatiens, fuchsia, and periwinkle. Black root rot was also identified in greenhouse pansy production in 1996.

**Coccomyces Leaf Spot of Cherry (*Blumeriella jaapii*).** This disease mainly affects the leaves, but lesions may also appear on fruit, petioles, and fruit stems. Small circular purple spots appear on the upper surface of the leaf and gradually enlarge to about 1/4" diameter and turn reddish-brown. The most conspicuous symptom, especially on sour cherries, is the golden yellowing of older leaves before they drop off. The homeowner can reduce the possibility of leaf spot by collecting and destroying the fallen cherry leaves in late autumn and by selecting a planting site that has good air circulation and drainage. Pruning to open the canopy to the sunlight can help as well.

**Herpobasidium Blight of Honeysuckle (*Herpobasidium deformans*).** This disease results in brownish, scorchy discoloration of the upper leaf surface, leaf curling, and a white fungal growth on the lower leaf surface. Looking at the leaf from above, the symptoms are similar to those seen with a severe spider mite infestation. From below, symptoms are suggestive of downy mildew disease. Infections can occur throughout the season during humid weather.

**The Whole World Turned Upside Down.** Reports this year included an incidence of Phomopsis disease occurring on spruce (*Phomopsis* sp.) and of Cytospora disease occurring on blue chip juniper *Cytospora* sp.). For those familiar with the much more common Phomopsis twig blight on juniper (*Phomopsis juniperovora*) and Cytospora canker on spruce (*Leucostoma kunzei*), the previous reports sound strangely reversed, but are true nevertheless. This is a reminder of the need for good laboratory confirmation of problems. For example, the Phomposis on spruce caused superficial symptoms of branch dieback including whitish resin

exudate, which looked similar to the familiar Cytospora canker symptoms on spruce.

**Pine-Pine Gall Rust (*Endocronartium harknessii*).** Several samples of this Scotch pine disease in Christmas tree plantations were sent to the PPDC this year and to several OSU Extension county offices. This autoecious rust (no alternate host) is characterized by globose to pear-shaped woody stemmed galls. Reddish-brown in color, the galls are approximately the shape and size of toasted marshmallows. Sprays are not effective except as preventives, since by the time noticeable galls form, initial infections are probably at least a year old. Development of spore masses from the galls usually do not occur until two to four years after infection.

**Verticillium Wilt (*Verticillium* spp.).** Samples were common on certain maples, barberry, and Russian olive. On a sample of white ash, this disease was a fooler; the streaking that we typically expect to see in the sapwood from Verticillium colonization and degredation was not present. Leaves that look scorched and are dropping are signals for possible Verticillium wilt.

Suspect samples of ash sent to the PPDC for confirmation should include sections of affected branches about a half-inch in diameter and leaves that are exhibiting the scorch symptom. Leaf samples should be fresh, not crispy, and taken from within the tree, not gathered off the ground.

**Downy Mildew of Viburnum (*Plasmopara viburni*).** This disease was quite prominent this year in many Ohio locations on cranberrybush viburnums and leather leaf viburnum. In some cases it resulted in leaf scorching and eventual loss of green foliage on over half the plant by late summer. This fungus is not related to the powdery mildew fungi that cause many different powdery mildew diseases. This downy mildew fungus is, however, whitish in color, though typically a little more off-white than powdery mildew fungi. On cranberrybush viburnum, the fungal growth is seen on the lower leaf surfaces; on corresponding upper leaf surfaces there is a leaf scorch symptom, often in blocky, angular patterns.

**Black Rot of Boston Ivy (*Guignardia bidwellii* f.sp. *parthenocissi*).** This disease was quite noticeable this year, causing tan to brown roughly circular lesions on Boston ivy and Virginia creeper. Black, pimple-like fungal fruiting bodies develop in the upper surfaces of these lesions. Some leaf distortion also occured from infections as leaves were expanding. Leaf tattering symptoms also developed as the lesions aged in many plantings. The fungus causing this disease is closely related to the grape black rot pathogen.

**Septoria Leaf Spot on River Birch (*Septoria* sp.).** Yellowing of leaves on river birch is sometimes a symptom of moisture stress in mid and late summer. In some cases, however, it may also be associated with *Septoria* infections. With Septoria leaf spot, look for brown spots and black fungal fruiting bodies in the center of the spots.

**Tubakia (Actinopelte) Leaf Spot (*Tubakia dryina*).** This was frequently reported both for pin oak (associated with interveinal leaf yellowing and brownish speckling due to iron deficiency) and on red oak (larger brown spots on otherwise green leaves). In neither case does this leaf spot disease typically threaten plant health.

**Phomposis Dieback of Buckthorn (*Phomopsis* sp.).** This uncommon disease, found at one site in Ohio in 1996, was associated with heavy use of an overhead irrigation system.

# Useful References

A list of useful references for diagnosing infectious and noninfectious disease problems on ornamental plants in the landscape is included on the following pages. This list includes everything from long reference books to short fact sheets, to World Wide Web sites, to a new compact disc with herbicide injury symptoms, to how to get the Buckeye Yard and Garden Line on your computer.

1. *A New Tree Biology.* Alex L. Shigo. 1994. Shigo and Trees, Associates, 4 Denbow Road, Durham, NH 03824. Can also be ordered through American Nurseryman Publishing Company.

2. *Ball Pest and Disease Manual.* 1992. Charles C. Powell & Richard K. Lindquist. Can be ordered through American Nurseryman Publishing Company.

3. *Buckeye Yard and Garden onLine.* The Ohio State University Department of Horticulture and Crop Science and Ohio State University Extension. Weekly updates April–October. A World Wide Web reference on OSU's Horticulture in Virtual Perspective's Webgarden site. Address: http://hortwww-2.ag.ohio-state

   The newest feature to the Web version of the Buckeye Yard and Garden Line (BYGL) is the incorporation of color slide images for some of the articles. You can also receive BYGL on your e-mail simply by requesting it from fischnich.1@osu.edu or by FAX from a number of OSU Extension offices.

4. *Common Insect Pests and Diseases of Ornamental Trees and Shrubs.* Ohio Nursery and Landscape Association. David J. Shetlar and James A. Chatfield. 1996. Also, an accompanying 160 color slide set and "Woody Ornamental Insect and Disease Fact Sheet Set." Ohio Nursery and Landscape Association, 72 Dorchester Square, Westerville, OH 43081-3350. 1-800-825-5062.

5. *Diseases and Pests of Ornamental Plants.* Pascal P. Pirone. 1978. 5th Edition. Can be ordered through American Nurseryman Publishing Company.

6. *Diseases of Trees and Shrubs.* Wayne A. Sinclair, Howard H. Lyon, and Warren T. Johnson. 1987. Cornell University Press, 124 Roberts Place, Ithaca, NY 14850. Can also be ordered through American Nurseryman Publishing Company.

7. *Insects That Feed on Trees and Shrubs.* Warren T. Johnson and Howard H. Lyon. 1991. 2nd Ed. Cornell University Press, 124 Roberts Place, Ithaca, NY 14850. Can also be ordered through American Nurseryman Publishing Company.

8. *Manual of Woody Landscape Plants.* Michael A. Dirr. 1990. Stipes Publishing Company, 10-12 Chester Street, Champaign, IL 61820. Can also be ordered through American Nurseryman Publishing Company.

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10. *Ohio State University Extension Fact Sheet Series.* Regularly updated. Extensive series on diseases, insects, environmental problems, and cultural practices for healthy ornamental plant growth. Available at Ohio State University Extension offices statewide; from the OSU Extension Publications Office, 2021 Coffey Road, Columbus, OH 43210-1044; and on OSU Extension's World Wide Web site, "Ohioline" at http://www.ag.ohio-state.edu.

11. *Ornamental Plants: Annual Reports and Research Summaries.* Ohio State University Ohio Agricultural Research and Development Center and Ohio State University Extension. Yearly Special Circulars (1995 — No. 142, 1996 — No. 152). OARDC Publications Office, 1680 Madison Avenue, Wooster, OH 44691.

12. *Ortho Problem Solver.* Edited by Michael D. Smith. 1994. 4th Edition. Ortho Books, Box 5407, San Ramon, CA 94583. Also can be ordered from American Nurseryman Publishing Company.

13. *Pests of Landscape Trees and Shrubs.* 1994. University of California. Can be ordered from American Nurseryman Publishing Company.

14. *Picture The Damage: Herbicide Damage Symptoms on Ornamentals.* Purdue University. 1996. Compact disc. Agricultural Communi-

cation Service, Media Distribution Center, 301 South Second Street, Lafayette, IN 47901-1232; 317-494-6794.

For additional information on this CD, please see the list of references on page 31 of this publication.

15. *The Compendia of Plant Disease Series.* American Phytopathological Society. Ornamental titles include:

    - Elm Diseases
    - Ornamental Foliage Plant Diseases
    - Rhododendron and Azalea Diseases
    - Rose Diseases

    APS Press, The American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121-2097. 1-800-328-7560.

16. *The Tree Worker's Manual.* S. J. Lilly. 1992. Revised Edition. Ohio Agricultural Curriculum Materials Service, The Ohio State University, 254 Agricultural Administration Building, 2120 Fyffe Road, Columbus, OH 43210-1010. 614-292-4848.

17. *Westcott's Plant Disease Handbook.* Cynthia Westcott, revised by Kenneth Horst. 1990. 5th Edition. Can be ordered from American Nurseryman Publishing Company.

## Address

American Nurseryman Publishing Company
77 Washington Street, Suite 2100
Chicago, IL 60602-2904
1-800-621-5727
FAX: 312-782-3232

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# Weed Problems in Ohio Landscapes and Nurseries: 1996

Gary Y. Gao, Charles T. Behnke, Joseph F. Boggs, Mary Ann Rose, Joseph W. Rimelspach, Randall H. Zondag, and William E. Pound

## Summary

Weeds such as crabgrass, rough bluegrass, wild violets, field horsetail, ragweed, dandelions, and poison ivy were reported to cause major problems to Ohio landscapes and nurseries. Mosses, mushrooms, and puffballs were also prevalent. In addition, there were several important changes in herbicide labels and a few new herbicide formulations. The article is a compilation of weed control notes from 1996.

## Introduction

Weeds presented serious problems to Ohio landscapes and nurseries in 1996. Weeds thrived in response to the cool and wet spring. Wet spring conditions may have led to difficulties in applying herbicides in a timely fashion and may have reduced the persistence of chemical controls in the landscape and nursery.

This report is a compilation of the noteworthy weed problems discussed during Buckeye Yard and Garden Line (BYGL) conferences that occurred weekly, from April to October in 1996.

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## Discussion

### Weather and Weed Control

During the week of May 9, 1996, we reported that wet cool weather impeded control of broadleaf weeds in lawns and that repeat herbicide applications would be needed to bring weeds under control. Lawn areas that were stressed last season, such as areas along driveways, sidewalks, and curbs, were filling in nicely with a variety of weeds, and control was not achieved until later in the season.

### Weed Control Failure in Nurseries and Landscapes

In nurseries, we reported during the week of June 27, 1996, that serious failure of pre-emergent weed control materials in northeast Ohio had occurred. Since weeds had germinated, nursery managers were given three options:

- Cultivation
- Cultivation combined with a second application of pre-emergent herbicide (as long as recommended seasonal rates are not exceeded)
- Application of post-emergent materials.

In landscapes, there was a crabgrass explosion in June. Warmth and moisture in May to early June produced a bumper crop of crabgrass in ornamental beds in 1996. Post-emergent grass herbicides such as Fusilade (fluazifop-P-butyl) or Vantage (sethoxydim) were recommended to help clean up the problem. The advantage of these herbicides over non-selective herbicides like Roundup (glyphosate) is that they may be used over the tops of many ornamentals.

## Crabgrass (*Digitaria* spp.) in Lawn

During the week of April 4, 1996, we suggested that there was still time to apply pre-emergent crabgrass controls across the state of Ohio. (Refer to the current OSU Extension Bulletin L-187 for labeled materials for crabgrass control.) The generally recommended treatment deadline for Ohio is: southern — April 7; central — April 16; and northern — May 1. However, since spring temperatures remained below normal across most of Ohio, the timing of pre-emergent controls for crabgrass in 1996 was modified as follows:

Southern Ohio — April 18/April 20-25
Central Ohio — April 20/April 25-30
Northern Ohio — May 1/May 8-10

## Rough Bluegrass (*Poa trivialis*)

During the week of April 4, 1996, it was reported that although lawns were beginning to green-up, rough bluegrass was already intensely green and giving lawns a "patchy" appearance. This cool season grass grows best from about early April until June. It prefers cool, moist conditions and is sometimes seeded into moist, shaded areas where it performs reasonably well. In full sun, rough bluegrass performs poorly. However, its early season surge coupled with a prostrate, vigorous, creeping growth habit often allows it to establish distinct patches within stands of preferred grasses.

Control of perennial rough bluegrass is difficult. A non-selective, post-emergent herbicide (e.g., Roundup or Finale) is required and multiple applications are needed. Applications should be started in late spring while the rough bluegrass is still vigorously growing. The application target area should extend 1–2 feet beyond the patches in order to kill advancing rough bluegrass stolons.

## Wild Violets (*Viola* spp.)

Wild violets were reported to degrade home lawns during the week of May 2, 1996. Wild violets are one of the most difficult weeds to control in the lawn. This perennial weed can persist in lawns indefinitely because of branching rootstocks and, in some species, stolons. Many species are well adapted to moderate shade conditions, but some will also establish and persist in sunny areas.

In June 1995, a wild violet control evaluation was conducted at Ohio State University. Herbicides evaluated in this study included 2,4-D, MCPP, 2,4-DP, dicamba, triclopyr, and clopyralid. Data collected seven weeks after treatment showed the phenoxy herbicides (2,4-D, MCPP, and 2,4-DP) and dicamba only provided 18.3% – 30.0% control following a single application. The best control of wild violet was achieved from two treatments containing tricloyr. The triclopyr + clopyralid and triclopyr treatments resulted in 73.3% – 81.7% control, respectively.

Homeowners wishing to control violets have a few options. First, wild violets can be eliminated from a lawn with repeated hand pulling or digging. Secondly, homeowners may use phenoxy herbicides; this will require numerous repeat applications over an extended period of time. The best option for homeowners is to hire a commercial lawn care firm to apply herbicides containing triclopyr. This product is available in DowElanco's Turflon Ester and Confront. Best control is achieved using triclopyr in liquid spray applications applied to runoff. Proper timing of application is between late April and mid-June or early September to mid-October.

## Field Horsetail (*Equisetum arvense*)

Field horsetail, a very troublesome weed, was discussed during the week of June 6, 1996. It is also called "scrub weed" and is a botanically interesting, but difficult to control weed, with an affinity for wet places. Because horsetail has an odd habit of accumulating silicon in cell walls, early settlers found the weed useful for scrubbing pots and pans. This primitive, spore-bearing plant also has been found in ancient fossils. But, all of this is small consolation to the nurserymen who are trying to eradicate this weed. Farmers don't like it either, because the plant is toxic to livestock.

Roundup (glyphosate) is sometimes recommended for control of this weed, but it hasn't been very effective. Repeated applications may help. Control has been achieved with applications of Casoron (dichlobenil), a soil-applied herbicide that is taken up by roots. However, a disadvantage with this chemical is its volatility in warm seasons. Its use is recommended for late fall and winter applications, as a soil surface or as incorporated treatments, or as a spring incorporated treatment. Incorporation can be achieved by shallow cultivation or irrigation. Six pounds of the active ingredient dichlobenil per acre will provide effective control of horsetail. For example, if you are using a 4G product (4% granule), this would translate into 150 pounds of product per acre, or 3.5 pounds per 1,000 square feet. Dichlobenil will move in the soil and down slopes, so it is important to keep this in mind when using this chemical. Many wet areas where the weed thrives may not be appropriate sites for using dichlobenil, particularly if they drain into an irrigation pond!

## Dandelions (*Taraxacum* spp.)

During the week of April 25, 1996, we reported that dandelions were blooming heavily in southern and central Ohio lawns. However, it was recommended that herbicide applications should be delayed until the dandelions reach the early puff-ball stage — the optimum stage for their control. An early herbicide application would result in later developing weeds such as plantain and oxalis being missed, requiring a second herbicide application. Usually, applications made in May (early for Southern, mid for Central, and late for Northern) will maximize the efficiency of broadleaf weed control measures.

## Poison Ivy (*Rhus radicans*)

During the week of June 20, 1996, poison ivy was reported showing up in ornamental shrub and perennial borders, probably seeded through bird droppings. When growing among desirable plants, poison ivy is a challenge to control.

Three methods were recommended:

- Grubbing or hand pulling the vine with gloves on, when the soil is wet.
- Severing the main vine and pulling it out of the existing vegetation, then treating new shoots that emerge with an herbicide to kill the roots.
- Treating the foliage with an herbicide, which may mean painting individual leaflets to avoid contacting landscape plant foliage.

Potassium salts of fatty acids (e.g., Sharpshooter) work well on seedling poison ivy, but older plants will only be suppressed with top kill, leaving roots to regenerate. Glyphosate (i.e., Roundup) is most effective when applied two weeks on either side of full bloom, in early summer. Ortho makes a couple of homeowner formulations, including triclopyr (i.e., Ortho Brush-B-Gon Poison Ivy Killer) and glyphosate (i.e., Kleeraway Grass & Weed Killer).

## Ragweed (*Ambrosia* spp.) vs. Goldenrod (*Solidago* spp.)

During the week of September 12, 1996, we received a few calls concerning plants that cause "hay fever." A lot of people blame goldenrod for their cold-like, miserable feelings. However, the real culprit is ragweed, known to cause widespread allergies in humans.

Morphologically, ragweed looks very different from goldenrod. The leaves of common ragweed are mostly alternate, nearly smooth, and deeply cut into a number of lobes. The leaves of goldenrod are tongue-shaped or oblong, without deep lobes. The flowers of ragweed are of two kinds. Male pollen-producing flowers are in small, inverted clusters at tips of branches. The seed-producing flowers are fewer, and borne at the base of the leaves and in forks of upper branches. The flowers of goldenrod are small and yellow, borne in large panicles with one-sided, recurving branches.

## Moss

Moss was reported during the week of May 16, 1996. It was favored by the wet conditions this spring. Homeowners may incorrectly believe that the moss is killing the grass when in fact, moss grows where environmental conditions

challenge turf growth and establishment. Generally, moss thrives in areas that have poor drainage, poor light quality, inadequate air circulation, low fertility, low or high pH, compacted soil, or a combination of these conditions. Although there are several materials labeled for moss control, they are considered a temporary solution. Moss can be successfully managed by correcting conditions which challenge turf establishment and growth. Nutrient deficits and low/high pH can be revealed and thus corrected by using a soil test. Soil compaction can be alleviated by core aeration; poor light quality and inadequate air circulation can be corrected by thinning or removing trees and shrubs.

## Mushrooms and Puffballs

During the week of May 16, we reported that conditions were "ripe" for the development of mushrooms and puffballs in Ohio lawns. They vary in shapes, sizes, and growth habits and are caused by fungi living on organic matter in the soil. To control mushrooms or puffballs, the organic food source they live on must be removed; this is a task generally impossible to accomplish. Proper fertilization and aeration can help. No fungicides are labeled for controlling these microbes.

## New Pesticides/Pesticide Labels in 1996

Scythe (Pelargonic acid) is a new post-emergence herbicide from Mycogen with a landscape, non-crop, golf course (edging), turf (site prep only), and greenhouse label. Its active ingredient is pelargonic acid. It is a contact herbicide and has a fatty acid chemistry, but is much stronger than Sharpshooter, another fatty acid herbicide. Like Sharpshooter, it can be legally used (carefully!) in greenhouses under benches while the crop is in place.

Scythe is a good contact herbicide in its own right, and when mixed with the translocated herbicide Roundup, improves rainfastness and penetration of that chemical into the leaf. This combination provides very rapid burndown of annual weeds, as well as some control of perennials. However, there is evidence that combining the contact herbicide with Roundup decreases roundup translocation, long-term, and provides less control of difficult perennial weeds than Roundup alone.

Monsanto's Roundup Herbicide for industrial, turf, and ornamental use is being replaced by Roundup PRO. Roundup PRO, like Roundup, is a 41% solution of the active ingredient, glyphosate, but contains an improved surfactant. The new surfactant in Roundup PRO improves foliar penetration and absorption of the herbicide. It has been a fairly common practice to use additional surfactant with Roundup to improve its effectiveness; this should no longer be necessary with Roundup PRO.

By the same token, where we may have been able to use Roundup with greater flexibility in the past, the new Roundup PRO should be used with even more respect around desirable plants! Advertised advantages of the new product include superior rainfastness and faster burndown. In addition, the EPA signal word has been downgraded from "Warning" to the lowest and safer category, "Caution."

## Useful References


1. Bill Pound, Dave Shetlar, Joe Rimelspach, and John Street. Ohio State University Extension Bulletin L-187, Control of Turfgrass Pests.

2. North Central Regional Research Publication No. 281, Weeds of the North Central States.

3. Herbicide Damage CD. Mike Dana and others at Purdue have developed a new CD titled "Picture The Damage! Herbicide Damage Symptoms on Ornamentals" which has more than 500 four-color images of herbicide damage from 12 different herbicides on 21 different ornamental plants. The cost of the CD is $39.95. For information and to order, contact the Agricultural Communication Service, Media Distribution Center, 301 South Second Street, Lafayette, IN 47901-1232. Phone: 317-494-6794; FAX 317-496-1540.

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# Wildlife Problems in Ohio Landscapes: 1996

Gary Y. Gao, Charles T. Behnke, and Joseph F. Boggs

## Summary

Wildlife such as rodents, rabbits, birds, deer, raccoons, and crayfish were reported to cause damage to Ohio landscape plants in 1996. The control measures for each of the specific wildlife vary.

However, the principles of wildlife damage prevention and control are similar. They include physical exclusion, live trapping, relocation of wildlife, alteration of habitats, shooting, and use of chemical and physical deterrents.

## Introduction

Prevention and control of wildlife damage are an increasingly important part of the wildlife management profession because of expanding human populations and intensified land-use. As more people move into previously agricultural areas, people and wildlife merge. People need to learn to deal with wildlife so that they may prevent or minimize damages to fruits, vegetables, trees, shrubs, and lawns. It is important to be aware of ways to handle wildlife problems as they relate to different geographic areas.

This report is a compilation of the noteworthy wildlife problems discussed during the Buckeye Yard and Garden Line (BYGL) conferences that occurred on Tuesdays, from April to October in 1996.

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## Discussion

### Rodents

Meadow mice were observed to leave extensive trails in northern Ohio lawns in the week of February 8, 1996. However, overall injury to turf appeared minimal in 1996.

### Rabbits

When food is in short supply over winter, rabbits will feed on the bark and stems of numerous trees and shrubs. Damage noted the spring of 1996 included injury on viburnum, winged euonymus, crabapple, rose, and other plants. Where feeding injury is noted, remove girdled stems, cutting back to a bud below the injury. If bark has been gnawed off main trunks, wait to see what the damage may be to the top. Additional pruning can be done once the shoots have leafed out and dead stems become evident.

Prevention is the best defense against rabbit damage. Modify their habitat by removing dense vegetation, brush piles, and weed patches. Also, attempt to exclude them from their favorite plants or plantings. In early winter, enclose vulnerable plants with one-inch mesh chicken wire fencing, two feet in height, either buried three inches into the ground, or staked to the ground.

### House Finches

House finches were observed nipping off one- to three-inch tips of *Taxus* plants in northeastern Ohio in the week of April 18, 1996, using some for their nests but leaving some litter as well.

Squirrels often have been blamed for nipping off tips of spruce and hemlock. Rarely have birds been connected with this kind of damage.

## Starlings

A homeowner was having trouble with nesting starlings in her patio area in the week of April 18, 1996. The long-term solution for this kind of problem is to alter the structure to prevent birds from nesting. When the nesting surface is a ledge, this may be accomplished by placing a metal cover or board over the ledge at a 45-degree angle (or greater). Make sure the ends are closed to prevent entry. Another method is to use "porcupine wires" that stick out and prevent birds from landing. Porcupine wires can be purchased from Nixalite of America (309-797-8771) or Shaw Steeple Jacks Inc. (814-266-8008). Some of the short-term solutions include a sticky repellent, scaring devices, or distress calls.

## Deer

Deer were reported to cause severe damage to apples and hostas in a home landscape in the week of April 18, 1996. Deer are very adaptable and are becoming a common problem in urban home landscapes.

Deer damage control measures include selection of "deer resistant" plants, herd management, repellents, and fencing. Published lists of "deer resistant" plants are available; however, it is difficult to know how reliable observations are since local conditions vary.

Deer herd management can be achieved with relocation of live animals and shooting/hunting — a difficult sell in urban areas. Deer repellents include "Deer-Away," "Hinder," "Thiram," "Miller's Hot Sauce Animal Repellent," "Tankage," "Ropel," hair bags, and bar soap. However, read the labels of commercial repellents to make sure target plants are listed. Many repellents are not labeled for food crops. Permanent, high-tensile electric fencing will provide year-round protection from deer damage. Refer to Wisconsin Extension Fact Sheet G3083, "Controlling Deer Damage in Wisconsin," for more information or contact Wisconsin Extension Publications at 608-262-3346.

## Raccoons

Several homeowners have reported damage to their landscape amelanchiers from raccoons, who had climbed up to pick a little ripe fruit in the week of July 4, 1996. In both cases, major branches were broken on the plant. This sort of damage is so random that controlling the animal is unnecessary, unless it becomes pesky in other ways.

## Crayfish

Crayfish and mowers clashed in southwestern Ohio the week of April 25, 1996. The burrowing crustaceans were making their mud "chimneys" in many lawns and wreaking havoc on mower blades. Some chimneys were over four inches in height.

Crayfish control can be challenging. Homeowners should be reminded that these are aquatic creatures, and their burrows extend down to water. Pouring insecticides in crayfish holes is not recommended and is against the law as there are no insecticides labeled for this use.

The University of Kentucky, Department of Entomology, offers several helpful treatments in one of their "EntFacts" titled, "Crayfish Control in Lawns." The publication indicates that the treatments are suggested by the U.S. Fish and Wildlife Service, USDA.

For example, one treatment is as follows: "Dissolve one pound of chloride of lime in three gallons of water. Application can be made with compressed air sprayers or a watering can with the sprayer nozzle removed. One or two ounces of liquid should be applied into each crayfish burrow and the opening of the burrow closed by pressing the earth together with the foot. The chloride of lime will kill the crayfish within a few hours."

# Useful References

1. *Prevention and Control of Wildlife Damage,* University of Nebraska.

   This publication is available in both book and electronic format (CD-Rom). Copies of the book are $40.00 each plus $5.00 shipping. CD-ROM copies of the publication are $40.00 each plus $3.00 shipping. Copies of the book plus CD-ROM are available at a discount price of $60.00 plus $5.00 shipping. Reduced shipping rates are available for orders of 10 or more. Call 402-472-2188 for information.

   Make check payable to University of Nebraska. Mail to:

   Wildlife Handbook
   202 Natural Resources Hall
   University of Nebraska
   P.O. Box 830819
   Lincoln, NE 68583-0819

2. Division of Wildlife, Ohio Department of Natural Resources.

   Wildlife District One
   1500 Dublin Road
   Columbus, OH 43215
   Phone: 614-644-3925

   Wildlife District Two
   952 Lima Ave., Box A
   Findlay, OH 45840
   Phone: 419-424-5000

   Wildlife District Three
   912 Portage Lakes Drive
   Akron, OH 44319
   Phone: 330-644-2293

   Wildlife District Four
   360 E. State Street
   Athens, OH 45701
   Phone: 614-594-2211

   Wildlife District Five
   1076 Springfield Pk, Box 576
   Xenia, OH 45385
   Phone: 513-372-9261

   In Sandusky
   Phone: 419-625-8062

# Evaluation of Crabapples for Diseases at the Secrest Arboretum in Wooster, Ohio: 1996

Erik A. Draper, James A. Chatfield, Kenneth C. Cochran, Peter W. Bristol, and Charles E. Tubesing

## Summary

Crabapples in a replicated plot at the Secrest Arboretum of The Ohio State University were evaluated for apple scab three times in 1996. Ten of the crabapple selections exhibited no scab at any of the ratings, while 16 of the selections exhibited scab rated as significantly damaging to plant aesthetics for at least one of the ratings. Apple scab was less severe in the plot in 1996 than in 1995, when 20 selections had ratings of significantly damaging scab. The same crabapple selections were also rated for scab on one date at Holden Arboretum and results were similar but with some differences.

Other diseases noted included bacterial fireblight, frogeye leaf spot, sooty blotch, and flyspeck. Frogeye leaf spot at Secrest Arboretum was considerably more severe than in previous years, resulting in some defoliation and significantly affecting plant aesthetics for two crabapple selections, and at least moderate effects on aesthetics for 11 additional selections.

## Introduction

Apple scab (pathogen: *Venturia inaequalis*) is a major fungal disease problem of many crabapple species (*Malus* spp). Although it generally is not a major health problem for the tree, it can severely impact ornamental effect and the marketability of highly susceptible crabapples.

Symptoms of apple scab on crabapple include olive to gray to brown to black spots on foliage, yellowing and discoloration of foliage, leaf drop, and scabby lesions on fruits. Apple scab can be effectively controlled with a fungicide spray program, and certain cultural and sanitary practices (thinning to avoid dense canopies, cleanup of leaves at the end of the season) are also beneficial for control.

However, the best method for control of apple scab is through the use of genetically resistant crabapple selections. The evaluations presented here are the latest in a series of apple scab evaluations for Ohio (1,2,3,).

The authors emphasize that apple scab in particular and diseases and pests in general are not the only consideration relative to crabapple effectiveness in the landscape. This is the rationale for the inception of more comprehensive evaluations of a number of different aesthetic criteria. These include fruit, flower and foliage features, plant texture and shape, and disease and pest problems. These are reported in a series of publications from data collected in the Secrest plot (4,5,6,7). The comprehensive crabapple evaluations at Secrest are a continuing project and are being expanded to include a second plot with additional selections.

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## Materials and Methods

Forty-five crabapples in the replicated crabapple plot at Secrest Arboretum were rated for apple scab disease on June 10, 1996; July 2, 1996; and August 9, 1996. This plot is in a completely randomized design with three replications of each crabapple selection (except for 'Red Jewel' and *M. zumi* 'Calocarpa,' each with two surviving replicates). The plot was planted in 1984 and is not treated with fungicides or insecticides.

Apple scab evaluations were based on the following rating system:

0 = No scab noted.

1 = Slight scab; less than 5% of leaves affected; no negative effect on aesthetics.

2 = Moderate scab; 5%–20% of leaves affected; some yellowing; little or no defoliation; moderate negative effect on aesthetics.

3 = Extensive scab; 20%–50% of leaves affected; significant defoliation and/or leaf yellowing; significant negative effect on aesthetics.

4 = Heavy scab; 50%–80% of leaves affected; severe defoliation and discoloration of leaves; severe negative effect on aesthetics.

5 = Extreme scab; 80%–100% of foliage is affected, and defoliation is complete or nearly complete.

Scab on crabapple fruits was factored into the overall scab ratings.

The same rating system was also used for frogeye leaf spot evaluations in 1996.

Frogeye leaf spot (pathogen: *Botryosphaeria obtusa*) is typically of minor concern relative to plant health and aesthetics, but on some selections in 1996, it caused significant leaf spotting, yellowing, and some defoliation. Severity of frogeye was greater than that noted in previous years of evaluations in the plot (2,3).

Fireblight (pathogen: *Erwinia amylovora*) is a serious bacterial disease causing blossom blight, twig and branch dieback, leaf discoloration, and in extreme cases total plant death. Fireblight was not a problem on most crabapple selections in this plot in 1996.

Sooty blotch (pathogen: *Gloeodes pomigena*) and fly speck (pathogen: *Microthyriella rubi*) caused considerable fruit unsightliness on several crabapple selections in the plot in 1996.

## Results and Discussion

Spring rains during leaf emergence and development in 1996 provided environmental conditions conducive to scab development, although scab was not as severe as in 1995. In general, scab ratings were similar to four-year averages. Early wet conditions and possible overwintering of the frogeye pathogen on infested fruit mummies may have contributed to increased frogeye leaf spot in 1996.

Of the 45 selections in this evaluation plot, 10 exhibited no scab in 1995 (Table 1). Of these 10, *M. baccata* 'Jackii,' 'Bob White,' 'Prairifire,' 'Red Jewel,' *M. sargentii* , and 'Strawberry Parfait' also had excellent overall aesthetic qualities and good resistance to other diseases. 'Dolgo,' 'Silver Moon,' and 'White Angel' were scab-free but had mediocre to poor overall aesthetic ratings. 'Silver Moon' also had some fireblight incidence, and 'Beverly' had significant frogeye leaf spot disease.

Scab ratings in this study were only for the 45 selections in the plot at Secrest Arboretum and at Holden Arboretum. This was done because of the replications in this plot as well as to avoid reporting data for just one plant and to facilitate monthly ratings of the Secrest Arboretum plot (4,5). However, there is additional data available for other Ohio locations and for other crabapple selections and locations for previous years in other publications (1,8,9).

In 1995–1996, ratings of crabapples at both Secrest Arboretum and Holden Arboretum near Mentor, Ohio, in northern Ohio near Lake Erie, were made in order to compare scab incidence for these two different environmental areas.

Results for Holden Arboretum in 1996 are included in Table 1 and indicate that scab incidence is generally similar for the two sites.

Frogeye leafspot was present on all crabapples in 1996, except for 'Sentinel,' and had significant negative effects on aesthetics on two crabapples ('Beverly,' 'Royalty') and moderate effects on aesthetics on 11 other crabapples in 1996.

Bacterial fireblight was present on five of the 45 selections in 1996 — 'Harvest Gold,' 'Mary Potter,' 'Silver Moon,' 'Red Jade,' and 'Winter Gold.' Fireblight was not severe in 1996 on any of the crabapple selections, even 'Harvest Gold' and 'Winter Gold,' which had hundreds of blossom blight infections leading to short shoot infections in 1995 (3).

Two additional disease problems noted the past two years are sooty blotch and fly speck, which resulted in overall smudging and ineffectiveness of ornamental fruit display. Significant aesthetic problems with these diseases were noted in 1996 on the following crabapple selections: 'Harvest Gold,''Professor Sprenger,' 'White Angel,' and 'Winter Gold.'

Powdery mildew and rust diseases were completely absent in this plot for 1993–1996. Insect problems in the plot included apple-and-thorn skeletonizer, Japanese beetle, spotted tentiform leafminer, and fall webworm. Ratings for apple-and-thorn-skeletonizer and Japanese beetle infestations are included in a companion article in this Circular (10).

**Table 1. Apple Scab Ratings for Crabapple Selections at Holden Arboretum (9-17-96), at Secrest Arboretum (6-10-96, 7-2-96, 8-9-96), and the average rating for Secrest Arboretum from 1993–1996.**

| Crabapple | Holden 9-17-96 | Secrest 6-10-96 | Secrest 7-2 96 | Secrest 8-9-96 | Secrest 1993–96 |
|---|---|---|---|---|---|
| 'Adams' | 2.6 | 1.6 | 2.0 | 2.0 | 1.7 |
| *M. baccata* 'Jackii' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Beverly' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Bob White' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Candied Apple' | 3.0 | 2.0 | 2.0 | 2.0 | 1.7 |
| 'Centurion' | 2.0 | 1.0 | 2.0 | 2.0 | 1.4 |
| 'David' | 1.0 | 0.0 | 1.0 | 1.0 | 0.9 |
| 'Dolgo' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Donald Wyman' | 1.0 | 1.0 | 1.0 | 2.0 | 1.1 |
| *M. floribunda* | 1.0 | 0.0 | 1.0 | 1.0 | 0.4 |
| *M. halliana* 'Parkmanii' | 1.0 | 0.6 | 1.0 | 1.0 | 0.6 |
| 'Harvest Gold' | 3.0 | 1.6 | 2.0 | 3.0 | 2.4 |
| 'Henningii' | 2.0 | 1.0 | 2.0 | 3.0 | 1.9 |
| *M. adstringens* 'Hopa' | 2.0 | 2.0 | 3.0 | 4.0 | 2.8 |
| 'Indian Magic' | 1.6 | 1.3 | 3.0 | 3.0 | 2.6 |
| 'Indian Summer' | 2.0 | 1.0 | 1.0 | 3.0 | 2.1 |
| 'Jewelberry' | 2.0 | 1.0 | 1.0 | 4.0 | 2.4 |
| 'Liset' | 0.0 | 0.3 | 1.0 | 2.0 | 1.0 |
| 'Mary Potter' | 1.0 | 0.3 | 0.3 | 0.3 | 0.5 |
| 'Molten Lava' | 1.0 | 0.0 | 1.0 | 1.0 | 1.1 |
| 'Ormiston Roy' | 1.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| 'Prairifire' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Professor Sprenger' | 1.0 | 0.0 | 1.0 | 1.0 | 0.8 |
| 'Profusion' | 2.0 | 1.3 | 3.0 | 3.0 | 2.7 |
| 'Radiant' | 2.0 | 2.0 | 3.0 | 5.0 | 3.1 |

Table 1 (Continued). Apple Scab Ratings for Crabapple Selections at Holden Arboretum (9-17-96), at Secrest Arboretum (6-10-96, 7-2-96, 8-9-96), and the Average Rating for Secrest Arboretum from 1993–1996.

| Crabapple | Holden 9-17-96 | Secrest 6-10-96 | Secrest 7-2 96 | Secrest 8-9-96 | Secrest 93-96 |
|---|---|---|---|---|---|
| 'Ralph Shay' | 2.0 | 1.0 | 1.0 | 2.0 | 2.0 |
| 'Red Barron' | 2.0 | 2.0 | 2.0 | 4.0 | 1.8 |
| 'Red Jade' | 1.0 | 1.0 | 1.0 | 1.0 | 1.2 |
| 'Red Jewel' | 0.0 | 0.0 | 0.3 | 0.3 | 0.1 |
| 'Red Splendor' | 1.6 | 1.0 | 2.0 | 3.0 | 1.5 |
| 'Robinson' | 2.0 | 1.3 | 2.0 | 3.0 | 2.5 |
| 'Royalty' | 2.0 | 2.0 | 3.0 | 2.0 | 1.8 |
| 'Ruby Luster' | 2.0 | 1.0 | 2.0 | 2.0 | 1.7 |
| *M. sargentii* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Selkirk' | 2.0 | 1.3 | 2.0 | 2.0 | 1.6 |
| 'Sentinel' | 1.0 | 0.0 | 1.0 | 1.0 | 0.7 |
| 'Silver Moon' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Snowdrift' | 2.0 | 1.0 | 2.0 | 3.0 | 2.2 |
| 'Strawberry Parfait' | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 'Sugar Tyme' | 1.0 | 0.3 | 0.3 | 1.0 | 0.7 |
| 'Velvet Pillar' | 2.0 | 1.6 | 2.0 | 3.0 | 2.7 |
| 'White Angel' | 0.0 | 0 .0 | 0.0 | 0.0 | 0.0 |
| 'White Cascade' | 2.0 | 1.6 | 3.0 | 3.0 | 2.2 |
| 'Winter Gold' | 1.0 | 1.6 | 3.0 | 3.0 | 2.3 |
| *M. zumi* 'Calocarpa' | 1.0 | 0.0 | 1.0 | 1.0 | 0.9 |

0 = No scab noted.
1 = Slight scab; less than 5% of leaves affected; no negative effect on aesthetics.
2 = Moderate scab; 5%–20% of leaves affected; some yellowing; little or no defoliation; moderate negative effect on aesthetics.
3 = Extensive scab; 20%–50% of leaves affected; significant defoliation and/or leaf yellowing; significant negative effect on aesthetics.
4 = Heavy scab; 50%–80% of leaves affected; severe defoliation and discoloration of leaves; severe negative effect on aesthetics.
5 = Extreme scab; 80%–100% of foliage is affected and defoliation is complete or nearly complete.

Scab on crabapple fruits was factored into the overall scab ratings.

Table 2. Frogeye Leaf Spot Ratings at Secrest Arboretum in 1996.

| Crabapple | 6-10-96 | 7-2-96 | 8-9-96 |
|---|---|---|---|
| 'Adams' | 1.3 | 1.0 | 1.0 |
| *M. baccata* 'Jackii' | 0.3 | 0.6 | 0.6 |
| 'Beverly' | 3.0 | 3.0 | 3.0 |
| 'Bob White' | 1.0 | 1.0 | 1.0 |
| 'Candied Apple' | 1.3 | 1.0 | 2.0 |
| 'Centurion' | 1.0 | 1.0 | 1.0 |
| 'David' | 1.3 | 1.3 | 1.0 |
| 'Dolgo' | 2.0 | 2.0 | 2.3 |
| 'Donald Wyman' | 1.0 | 1.3 | 1.3 |
| *M. floribunda* | 0.3 | 1.0 | 1.0 |
| *M. halliana* 'Parkmanii' | 0.3 | 1.0 | 1.3 |
| 'Harvest Gold' | 1.0 | 1.0 | 1.0 |
| 'Henningii' | 1.0 | 1.0 | 1.3 |
| 'Hopa' | 0.6 | 2.0 | 2.3 |
| 'Indian Magic' | 1.3 | 1.0 | 1.3 |
| 'Indian Summer' | 1.3 | 1.0 | 1.0 |
| 'Jewelberry' | 0.6 | 1.0 | 1.0 |
| 'Liset' | 1.0 | 1.0 | 1.3 |
| 'Mary Potter' | 1.0 | 1.0 | 1.0 |
| 'Molten Lava' | 0.3 | 1.0 | 1.0 |
| 'Ormiston Roy' | 1.3 | 1.0 | 1.0 |
| 'Prairifire' | 1.0 | 1.0 | 1.0 |
| 'Professor Sprenger' | 1.3 | 2.0 | 2.0 |
| 'Profusion' | 1.0 | 1.0 | 1.0 |
| 'Radiant' | 1.0 | 2.0 | 2.0 |
| 'Ralph Shay' | 1.0 | 2.0 | 2.0 |
| 'Red Barron' | 2.0 | 2.0 | 2.0 |
| 'Red Jade' | 0.6 | 1.0 | 1.0 |
| 'Red Jewel' | 1.0 | 1.0 | 2.0 |
| 'Red Splendor' | 2.3 | 2.0 | 2.3 |
| 'Robinson' | 1.3 | 1.3 | 1.3 |
| 'Royalty' | 2.0 | 2.3 | 3.3 |
| 'Ruby Luster' | 1.0 | 1.0 | 1.0 |
| *M. sargentii* | 0.6 | 1.0 | 1.3 |
| 'Selkirk' | 1.6 | 2.3 | 2.0 |
| 'Sentinel' | 0.0 | 0.0 | 0.0 |
| 'Silver Moon' | 0.0 | 1.0 | 1.3 |
| 'Snowdrift' | 1.0 | 1.0 | 1.0 |
| 'Strawberry Parfait' | 0.3 | 0.6 | 1.0 |
| 'Sugar Tyme' | 1.3 | 1.3 | 1.3 |
| 'Velvet Pillar' | 1.0 | 1.0 | 1.3 |
| 'White Angel' | 0.6 | 0.6 | 1.0 |
| 'White Cascade' | 1.0 | 1.6 | 1.3 |
| 'Winter Gold' | 1.6 | 1.6 | 2.0 |
| *M. zumi* 'Calocarpa' | 1.0 | 1.0 | 1.0 |

Table 2 (Continued). **Frogeye Leaf Spot Ratings at Secrest Arboretum in 1996.**

Frogeye leaf spot evaluations were based on the following rating system:

0 = No frogeye noted.
1 = Slight frogeye; less than 5% of leaves affected; no negative effect on aesthetics.
2 = Moderate frogeye; 5%–20% of leaves affected; some yellowing; little or no defoliation; moderate negative effect on aesthetics.
3 = Extensive frogeye; 20%–50% of leaves affected; significant defoliation and/or leaf yellowing; significant negative effect on aesthetics.
4 = Heavy frogeye; 50%–80% of leaves affected; severe defoliation and discoloration of leaves; severe negative effect on aesthetics.
5 = Extreme frogeye, 80%–100% of foliage is affected, and defoliation is complete or nearly complete.

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# Duration of Fruit Effectiveness and Blossom Longevity in Ornamental Crabapples at Secrest Arboretum in Wooster, Ohio: 1995–1996

James A. Chatfield, Erik A. Draper, and Kenneth D. Cochran

## Summary

Forty-five ornamental crabapple (*Malus* spp.) selections were evaluated for time of blossom emergence, blossom longevity, and duration time of ornamental effectiveness of fruits. Flowers were evaluated daily during bloom, while fruit qualities were evaluated bi-weekly from petal fall to bud emergence in the spring of 1996. Blossom Time Index and blossom longevity are reported as an average of cumulative ratings of the past two years. 'Strawberry Parfait' had the most durable blossoms for 14.5 days while 'Hopa' and 'Velvet Pillar' averaged only six days. The longest season of effective fruit was nearly nine months, while the shortest was just over three weeks. In addition, 12 crabapple selections in the plot never had ornamentally effective fruit

## Introduction

The use of flowering crabapples (*Malus* spp.) in the landscape tends to focus attention on floral colors and effects while ignoring the aspect of fruit. In our opinion, fruit appeal and retention will create a much longer lasting impact in the landscape than will blossoms. Traditionally, many older crabapple selections had large fruit creating huge messes and headaches for homeowners when fruit drop occurred. Consequently, to sell crabapples, retailers began to emphasize the flowering characteristics and de-emphasize fruit. This tendency is still a common practice in most garden and landscape centers today.

However, with the release of many new superior, small-fruited crabapples, the season of fruit effectiveness can and should be a major selling point. Bloom is directly affected by environmental factors (e.g., wind, rain, freezes, frosts, high and low temperatures) which usually decrease bloom longevity and aesthetics. On the other hand, crabapple fruit tends to be less reactive to those same environmental impediments. Some fruit will even increase appeal while maturing during such environmental stimulus.

This study was initiated to determine relative times of blossom emergence, longevity of bloom, and season of fruit appeal. By comparing effective bloom length to total length of fruit effectiveness, less emphasis may be placed on bloom, and greater emphasis more appropriately placed on season of fruit effectiveness in the landscape.

## Materials and Methods

Forty-five selections of crabapples at the Secrest Arboretum in Wooster, Ohio, were evaluated daily, 27 total times, from April 26, 1995, through May 22, 1996. Recorded observations for each crabapple included day of first blos-

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som fully open, through and up to the date when blooms were past effectiveness (50% or greater loss of overall blossoms). Den Boer (1) offered a method, Blossom Time Index, to standardize blossom emergence. Using the earliest flowering crabapple as a reference base, all subsequent crabapple bloom emergence was based on number of days after the reference bloom. The reference base for the Secrest plot was the crabapple, 'Dolgo.' The Blossom Time Index and the duration of bloom will be reported as averages of 1995 and 1996 findings.

The same 45 crabapples were also evaluated to determine the season of fruit effectiveness. Observations were recorded bi-weekly from petal fall (mid-May 1995) until all selections of crabapples lost their aesthetic appeal, fruitwise, or upon emergence of new buds (mid-April 1996). The season of effective fruit defines days 1–10 of each month as early, days 11-20 as mid, and days 21-31 as late.

These crabapple selections were planted in 1984 in a completely randomized design with three replications of each selection. The cultural practices used to maintain the crabapple plot are minimal pruning, a 6–8 foot diameter mulch ring of 1- to 2-inch depth around each tree, and removal of rootstock suckers and dead branches, thereby mimicking those cultural practices of an average landscape.

## Results and Discussion

The reference base crabapple, 'Dolgo,' bloomed on April 26, 1996, and 14 days later, on May 10, 1996, both 'Mary Potter' and 'Silver Moon' were the last to begin flowering in the plot. 'Strawberry Parfait' had the most durable flowers, averaging 14.5 days. Conversely, 'Hopa' and 'Velvet Pillar' averaged the shortest duration of six days. The average bloom length for 30 crabapple selections was 10–14.5 days. The remaining 15 selections had an average bloom length of 6–9.5 days.

Overall, the average number of days of bloom duration was shorter this year than last year. This was due to uncontrollable environmental factors that occurred this year during bloom, like rain on six of the 27 total days. Torrential rain showers knocked the petals off many selections one afternoon. Also, a light frost caused flowers on some selections to yellow or brown early, which contributed to reduction of days of effective bloom. A few trees showed an increase in days of effective bloom which could be attributed to the "profuse flowering year" of a selection that alternates yearly on a profuse to sparse cycle.

The same 45 crabapples showed great variability in length of fruit effectiveness. The longest season of effective fruit was at least nine months for 'Indian Magic' and 'Indian Summer.' The shortest season of effective fruit was just over three weeks for *M. floribunda*, *M. halliana* 'Parkmanii,' and 'Silver Moon.' Eight crabapples exhibited at least six months of effective fruit. Nine selections exhibited only a three- or four-month fruit season; 13 selections exhibited only a one- or two-month season; and 12 crabapples never had a season of effective fruit. Thirty of the total 45 crabapples showed at least one month of effective fruit. The highest total number was in the group of greater than one month but less than two months of effective fruit with 10 crabapples, followed by the greater-than-three-months-but-less-than-four-months group which contained six crabapples.

If one were to compare 14.5 days of bloom against at least nine months of effective fruit, there really is no question as to which event has the greatest impact in the landscape. Even the shortest season of effective fruit (>3 weeks) is almost double the time of the longest bloom duration (14.5 days). Continuing to promote, sell, design with, or use crabapples simply as attractive "flowering trees" is to ignore the most prominent feature of this tree, namely the "crabapple." With landscape trends moving towards multiple season effects, who would pass up a chance to impact an area with color for months? Why not promote "a great tree providing such colored fruit for this amount of time" that just happens to have gorgeous flowers also. There is so much more to crabapples than just flowers, and in our opinion, it is the fruit!

To be a viable landscape element, additional aspects must be factored into the "crabapple use equation" other than just fruit or flower.

It must be noted that these fruit and flower observations are limited to one site, Secrest Arboretum in Wooster, Ohio. The flower observations reflect only two years of data while the fruit observations are for one year only. Other limitations of this study include preferential biases which may influence evaluators, the inability to maintain equivalent weather conditions throughout the blossom period, and lack of environmental modifications to reduce tree stress cycles, which can affect bloom initiation and fruit retention.

**Table 1. Fruit and Flower Observations of Selected Crabapples**

**'Adams'** {Deep red fruits, pink flowers.} Firm, abundant tear-drop shaped fruits were effective late July through mid-December. Mummified fruit is a real problem, with some persisting as long as three years. Average days of bloom — 10.

*M. baccata* **'Jackii'** {Maroon-red fruits, white flowers.} Very attractive, round burgundy fruits were effective late September through mid-November. Although flowers are consistent and plentiful, fruit tends to be relatively sparse and scattered throughout the tree. Prolific, large white blooms are impressive. Average days of bloom — 9.5.

**'Beverly'** {Bright pinkish-red fruits, white flowers.} Fruits were effective mid-August through late September. Unfortunately, blackened rotting fruits persist through winter. Fruits are partially eaten by birds, leaving an unsightly mess on the tree. Snowy white flowers from pink buds are splendid. Average days of bloom — 11.5.

**'Bob White'** {Yellow fruits, white flowers.} Small, firm, yellow-gold fruits maturing into orange-gold were effective mid-October through late January. Birds readily eat the fruit within a week's time. Exceptional floral display

**Table 1 (Continued). Fruit and Flower Observations of Selected Crabapples**

of delicate white blossoms opening from pinkish-red buds. Fruit and floral displays can be somewhat erratic, alternating from profuse to sparse. Average days of bloom — 12.

**'Candied Apple'** {Cherry red fruits, pink flowers.} Round, namesake fruits were not effective at any time during the past two years due to intense scab infections. Unfortunately, all fruit effects were negated by masking "namesake red" with brown to grayish-green scab lesions. Large pink blooms are consistent and charming. Average days of bloom — 11.5.

**'Centurion'** {Glossy red fruits, rose-red flowers.} Abundant fruits were effective early September through mid-October, becoming dull thereafter. Large consistent flowers provide an outstanding display. Average days of bloom — 11.

**'David'** {Scarlet fruits, white flowers.} Medium-sized round fruits were effective late September through early November. Fruit and floral displays can be somewhat erratic, alternating from profuse to sparse. Abundant snowy-white flower display in the "on" year is enchanting. Average days of bloom — 10.5.

**'Donald Wyman'** {Bright red fruits, white flowers.} Persistent round, glossy fruits were effective late September through mid-April. Fruit remained firm the entire time, turning a muddied-red after a few hard freezes. Mummified fruit may be a problem in some years. One of the best red-fruited crabapples with a superb floral display. Average days of bloom — 10.

*M. floribunda* {Fruit yellow with red blush, white flowers.} Attractive blend of yellow maturing to a cider-brown colored fruit effective mid-October through early November. Pink-red buds open to white flowers creating a pleasing, airy floral display. Average days of bloom — 12.5.

*M. halliana* **'Parkmanii'** {Red fruits, double pinkish white flowers.} Small round commingled golden yellow and "cider" red-brown colored fruits effective from mid-October through early November. Light, airy, delicate blooms from red-pink buds create an astonishing floral display. Average days of bloom — 13.

**'Harvest Gold'** {Yellow to gold fruits, white flowers.} When the bland green fruit finally did mature (late October), the yellow fruits were so dull and dingy from sooty blotch fungus that they were never effective. Could be very attractive with red pedicels setting off the clusters of yellow fruit. Average days of bloom — 9.

**'Henningii'** {Orange-red fruits, white flowers.} Small, round fruit was effective late September through early November. Very profuse flower display. Average days of bloom — 11.5.

**'Hopa'** {Red fruits, muted purple to pink flowers.} Due to severe scab the large fruit was gnarly and deformed from the feeding of the codling moth larva. This "wormy" fruit drops all summer long. Consequently, this fruit was never effective. Pastel flower show in spring is beautiful. Average days of bloom — 6.

**'Indian Magic'** {Red-orange fruits, pink flowers.} Exceptional display of autumnal orange-red, oval-shaped fruits with golden orange undersides effective early June through late March. Outstanding pink floral show is consistent performer. Average days of bloom — 10.5.

**'Indian Summer'** {Red fruits, rose red flowers.} Prolific round, medium-sized fruits were effective early June through mid-February. Large flowers create a wonderful sight. Average days of bloom — 13.

**'Jewelberry'** {Red fruits, white flowers.} Scanty fruits were ravaged early by scab infections, and those that escaped the fungus were rarely noticed. Fruits that do color up tend to shrivel and drop rapidly. Tiny, petite flowers enhance the diminutive form of this crabapple. Average days of bloom — 12.5.

**'Liset'** {Maroon-red fruits, rose red flowers.} Dark, glossy fruits were effective late July through mid November. Fruits were scattered throughout the tree and never really attained an "eye catching" appeal. Flower display was very enjoyable but lacked contrast with the new foliage. Average days of bloom — 12.

**'Mary Potter'** {Red fruits, white flowers.} Profuse small fruits outline branching structure mid-August through late November. Fruit and floral displays can be somewhat erratic, alternating from profuse to sparse. Masses of pink buds open to provide a glorious flower display. Average days of bloom — 8.

**'Molten Lava'** {Red-orange fruits, white flowers.} Prolific fiery red fruits were effective early August through mid-November. Exquisite flower display is dependable and unrivaled year after year. Average days of bloom — 10.

**'Ormiston Roy'** {Orange-yellow fruits, white flowers.} Glossy, oval-shaped fruits are an attractive orange-yellow blush with creamy yellow underside. Fruits were effective mid-September through mid-April, remaining firm and turning a muddied red-orange color. Splendid floral show from pink buds. Average days of bloom — 11.

**'Prairifire'** {Purple-red fruits, coral-red flowers.} Attractive, shiny, firm purplish fruits with white speckles were effective early July through mid-November. Bloom color is unique and spectacular. Average days of bloom — 9.5.

**'Professor Sprenger'** {Orange-red fruits, white flowers.} Large yellowish-green fruits mature in late September to orange-red. Fruit appear dull, dingy, and occluded from sooty blotch and fly speck fungus covering the skin. The lack of fruit finish and problems with persistent mummified

fruits result in a lack of an effective fruit season. Very attractive large white floral display. Average days of bloom — 9.5

**'Profusion'** {Red fruits, purple-red flowers.} Abundant cherry-red fruits were effective mid-July through mid-October. Unfortunately, the unfailing floral show is muted by the lack of contrast with the newly emerged foliage. Average days of bloom — 8.

**'Radiant'** {Bright red fruits, deep pink flowers.} Because of severe scab problems this fruit was ruined almost as fast as it developed. Those that escaped scab infections were virtually a neon-red, but inclined to create additional problems by mummifying and clinging to the tree well into the next summer. Pink blossoms are pleasant. Average days of bloom — 8.5.

**'Ralph Shay'** {Large red fruits, white flowers.} Very large, bright red fruits can be effective early September through mid-November if they could develop before insect damage (codling moth) makes fruit gnarly and unsightly. Mummified fruit can be a problem also. Very pleasing floral display. Average days of bloom — 8.5.

**'Red Barron'** {Dark red fruits, reddish-pink flowers.} Unique pumpkin-shaped fruits blacken early and are very susceptible to scab, hence this fruit is never effective. Fruits mummify easily and may remain on the tree for as long as two years. Mediocre flower show in part due to sparseness. Average days of bloom — 10.

**'Red Jade'** {Red fruits, white flowers.} Attractive medium-size fruits were profuse and effective late September through mid-November. Small red flower buds swell to large pink buds, opening into snowy white blossoms. Reliable fruit and flower display year after year. Average days of bloom — 11.

**'Red Jewel'** {Cherry red fruits, white flowers.} Phenomenally attractive, persistent fruits were

Table 1 (Continued). Fruit and Flower Observations of Selected Crabapples

effective early September through mid-April. Fruits remained firm and turned a muddy-red color. Abundant blooms of sugar white envelop the tree. Fruit and floral displays can be somewhat erratic, alternating from profuse to sparse. Average days of bloom — 9.5.

**'Red Splendor'** {Roundish red fruits, rose pink flowers.} Exceptional, profuse red fruits are effective from late May through mid-December. In the late fall fruit begins to fade to an orange salmon color. Rotted, half-eaten fruits can be unsightly in the winter. Lovely pink blooms are quite persistent. Fruit and flower arrays are exceptional, profuse, and never falter. Average days of bloom — 13.

**'Robinson'** {Dark red fruits, deep pink flowers.} The combination of murky green leaves with maroon highlights does little to contrast the fruit which is lost in the foliage. This lack of contrast and small size of fruit result in the fruit never being effective. Flower display is quite attractive. Average days of bloom — 9.

**'Royalty'** {Red-purple fruits, crimson flowers.} Due to the deep red-purple foliage, not only were the fruits vaguely noticed but the flowers were lost as well. Fruit mummies blacken then fade to gray and remain well into the next summer. Fruit never was effective. Average days of bloom — 10.5.

**'Ruby Luster'** {Rose-purple fruits, pink flowers.} Fruits were large with a rough, scaly finish, muddied color and generally misshapen from the codling moth larva. Fruits were never effective. Diminutive flowers are hidden by newly-emerged foliage. Average days of bloom — 10.5.

*M. sargentii* {Red fruits, white flowers.} Small, round firm fruits were effective mid-August through late November. Fruits go bad rapidly, shriveling and wrinkling, which can be effective for a few weeks and persist raisin-like into

Table 1 (Continued). Fruit and Flower Observations of Selected Crabapples

winter. Fine snowy white blossom show. Average days of bloom — 9.5.

**'Selkirk'** {Glossy red fruits, rose red flowers.} Medium-large fruits were effective from early June through mid-August. Fruits lose their impact due to disfiguration by codling moth larvae feeding and apple scab. Excellent floral show complements emerging glossy, red-tinged foliage. Average days of bloom — 11.

**'Sentinel'** {Red fruits, red-pink buds open to pink-tinged white flowers.} Attractive firm, small round fruits persisted from early September through late March. Fruit mummies are sometimes a problem in the spring and summer. The bud and flower display is spectacular and reliable. Average days of bloom — 11.

**'Silver Moon'** {Purple-red fruits, white flowers.} Dark, unique colored, high-gloss fruits were effective early September through early October. Fruit and floral displays can be somewhat erratic, alternating from profuse to sparse. One of the last crabapples to bloom offering a snowy white floral show. Average days of bloom — 8.5.

**'Snowdrift'** {Salmon-red fruits, white flowers.} Distinctly colored, small round fruits were effective late September through mid-November. Excellent flower display that is consistent year after year. Average days of bloom — 10.5.

**'Strawberry Parfait'** {Fruits start cream yellow with increasing red blush, pink flowers.} Profuse firm fruits were effective early June through mid-February. Incredible pink flower display is one of the most durable. Average days of bloom — 14.5.

**'Sugar Tyme'** {Brilliant red fruits, white flowers.} Persistent, showy, firm medium-sized fruits were effective mid-September through mid-April. Fruits remained firm and turned a reddish brown color. Sugar-white floral display is stunning. Average days of bloom — 11.

Table 1 (Continued). Fruit and Flower Observations of Selected Crabapples

**'Velvet Pillar'** {Reddish fruits, pink flowers.} Lack of contrast between fruit and foliage and overall meager fruit inhibit this crabapple from ever being effective. Fruit which does appear tends to mummify and remain on the tree well into the spring. Floral show is typically unnoticed. Average days of bloom — 6.

**'White Angel'** {Red fruits, white flowers.} Medium-sized abundant fruits were effective mid-November through mid-December. Fruit finish was marred by sooty blotch and flyspeck fungus resulting in a dull, dingy look until late into the season. Very attractive, large, showy white flowers. Average days of bloom — 9.5.

**'White Cascade'** {Small yellow fruits, white flowers.} Sadly, fruits rarely created an impact and were never effective because scab covered almost the entire fruit. An exquisite flower display on cascading branches. Average days of bloom — 11.5

**'Winter Gold'** {Yellow fruits, white flowers.} Bright red pedicels contrast with clusters of butter yellow fruits which were effective early November through mid-December. Fruits were some of the last to color up. Fruit and floral displays can be somewhat erratic, alternating from profuse to sparse. Attractive flower show in years where blooms are present. Average days of bloom — 12.5.

*M. zumi* **'Calocarpa'** {Bright red fruits, white flowers.} Clusters of abundant, tiny, glossy fruit were effective mid-September through mid-December. Excellent flower show from red-pink buds. Average days of bloom — 10.5.

Table 2. Emergence, Duration of Bloom, and Season of Effective Fruit of Selected Crabapples

| Crabapple | 2-Yr. Avg. Days from Ref. Base | 2-Yr. Avg. Days of Bloom Duration | 1995–1996 Season of Effective Fruit |
|---|---|---|---|
| **Very Early** | | | |
| 'Dolgo' | 0 | 13.5 | late Aug. — late Sept. |
| **Early** | | | |
| 'Beverly' | 4 | 11.5 | mid Aug. — late Sept. |
| 'Red Splendor' | 4 | 13 | late May — late Sept. |
| 'Selkirk' | 4 | 11 | early June — mid Aug. |
| 'Strawberry Parfait' | 5 | 14.5 | early June — mid Feb. |
| *M. baccata* 'Jackii' | 5.5 | 9.5 | late Sept.- mid Nov. |
| 'Indian Summer' | 6 | 13 | early June — late Mar. |
| 'Jewelberry' | 6.5 | 12.5 | See description |
| **Mid-Season** | | | |
| 'Candied Apple' | 7 | 11.5 | See description |
| *M. floribunda* | 7 | 12.5 | mid Oct. — early Nov. |
| *M. halliana* 'Parkmanii' | 7 | 13 | mid Oct. — early Nov. |
| 'Ormiston Roy' | 7 | 11 | late Sept. — mid April |
| 'Ralph Shay' | 7 | 8.5 | early Sept. — mid Dec. |
| 'Radiant' | 7.5 | 8.5 | See description |
| 'Sentinel' | 7.5 | 11 | early Sept. — late Mar. |
| *M. adstringens* 'Hopa' | 8 | 6 | See description |
| 'Ruby Luster' | 8 | 10.5 | See description |
| 'White Cascade' | 8 | 11.5 | See description |
| 'Red Barron' | 8 | 10 | See description |
| 'Bob White' | 8.5 | 12 | mid Oct. — late Jan. |
| 'Red Jade' | 8.5 | 11 | late Sept. — mid Nov. |
| 'Sugar Tyme' | 8.5 | 10.5 | late Sept. — mid April |
| 'Adams' | 8.5 | 10 | late Aug. — mid Dec. |
| 'Centurion' | 8.5 | 11 | early Sept. — mid Oct. |
| 'Henningii' | 8.5 | 11.5 | late Sept. — early Nov. |
| 'Indian Magic' | 8.5 | 10.5 | early June — late Mar. |
| 'Royalty' | 8.5 | 10.5 | See description |
| 'Professor Sprenger' | 9 | 9.5 | See description |
| 'White Angel' | 9 | 9.5 | mid Nov. — mid Dec. |
| 'Winter Gold' | 9 | 12.5 | early Nov. — mid Dec. |
| 'David' | 9.5 | 10.5 | late Sept. — early Nov. |
| 'Molten Lava' | 9.5 | 10 | mid Aug. — mid Nov. |
| 'Profusion' | 9.5 | 8 | late July — mid Oct. |
| 'Snowdrift' | 9.5 | 10.5 | late Sept. — mid Nov. |

Table 2 (Continued). Emergence, Duration of Bloom, and Season of Effective Fruit of Selected Crabapples

| Crabapple | 2-Yr. Avg. Days from Ref. Base | 2-Yr. Avg. Days of Bloom Duration | 1995–1996 Season of Effective Fruit |
|---|---|---|---|
| **Late** | | | |
| 'Robinson' | 10 | 9 | See description |
| *M. zumi* 'Calocarpa' | 10 | 10.5 | late Sept. — mid Dec. |
| 'Donald Wyman' | 10.5 | 10 | late Sept. — mid April |
| 'Liset' | 10.5 | 12 | late July — mid Nov. |
| 'Red Jewel' | 11.5 | 9.5 | early Sept. — mid April |
| 'Harvest Gold' | 12.5 | 9 | See description |
| 'Prairifire' | 12.5 | 9.5 | early July — mid Nov. |
| 'Velvet Pillar' | 13 | 6 | See description |
| 'Mary Potter' | 13.5 | 8 | mid Aug. — late Nov. |
| *M. sargentii* | 13.5 | 9.5 | mid Aug. — late Dec. |
| 'Silver Moon' | 15.5 | 8.5 | early Sept. — late Sept. |

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# Evaluation of Crabapples for Apple-and-Thorn Skeletonizer and Japanese Beetle Feeding Damage at Secrest Arboretum: 1996

David J. Shetlar, James A. Chatfield, Eric Draper, and Kenneth D. Cochran

## Summary

A planting of 59 selections of crabapples was rated for apple-and-thorn skeletonizer (ATS) damage and Japanese beetle (JB) adult feeding on August 9, 1996, at the Secrest Arboretum, Wooster, Ohio. Significant differences in crabapples with ATS damage were observed. Seven cultivars had 10% skeletonization or less while 21 cultivars had 50% leaf skeletonization, which was deemed unacceptable. JB adult feeding was less severe than ATS in 1996. Thirteen cultivars sustained very little skeletonization, while 12 cultivars had more than 50% of the leaves skeletonized.

## Introduction

In 1984, 45 cultivars of crabapple were established with three replicates in a completely randomized plot at the Secrest Arboretum, Wooster, Ohio. In 1991, an additional 14 cultivars were added to the plot, with 'Golden Raindrops' losing one replicate. By 1996, one replicate each of 'Red Jewel' and *M. zumi* 'Calocarpa' was lost. The trees in this plot were evaluated in 1994 and 1995 for growth habits and disease incidence (Chatfield et al., 1996; Draper et al.,1996). In 1996, the disease ratings were again taken, and severe skeletonizing damage was noted. This damage was caused by a caterpillar, the apple-and-thorn skeletonizer (ATS), *Choreutis pariana* (Clerck) [Lepidoptera: Choreutidae], and Japanese beetles (JB), *Popillia japonica* Newman [Coleoptera: Scarabaeidae]. Some cultivars appeared to be attacked preferentially, so an evaluation of the skeletonizing damage by ATS and JB was performed and is herein presented.

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## Materials and Methods

The 59 cultivars of crabapples were evaluated for leaf skeletonization damage on August 9, 1996, by a single evaluator (DJS). ATS larvae fold individual leaves together with silk webbing. Within this webbing and leaf protection, the ATS larvae skeletonize the leaves by feeding only on the upper leaf surface. Japanese beetle adults generally land on upper leaves of trees and skeletonize the leaves by eating upper, middle, and lower tissues between larger veins.

Because of the types of feeding and difficulty in reaching upper parts of the trees, two rating systems of skeletonizing were used. For ATS, a branch on the southwestern portion of the tree was selected, and the first 10 leaves were rated. A rating of 0 to 10 was recorded where 0 = no webbing or skeletonized leaves observed and 10 = all 10 leaves webbed or skeletonized.

For JB, a visual rating of JB skeletonizing was given after walking around each tree, observing damage. A rating of 0 to 5 was recorded where 0 = no JB skeletonizing noted and 5 = almost every leaf skeletonized by JB. Rating data were

analyzed using ANOVA followed with LSD mean separation at $p = 0.01$ (MSTAT, Michigan State University).

## Results

Significant differences between crabapple selections were detected for ATS damage ($df = 58$, $F = 5.82$, $p < 0.001$) and for JB skeletonizing ($df = 58$, $F = 4.54$, $p < 0.001$). For ATS damage, 'Bob White,' 'David,' 'Indian Summer,' 'Red Jewel,' 'Snowdrift,' 'White Cascade,' and 'Golden Raindrops' had the least damage (10% or fewer leaves skeletonized). 'Candied Apple,' 'Centurion,' 'Dolgo,' *M. floribunda*, 'Molten Lava,' 'Ormiston Roy,' 'Professor Sprenger,' 'Profusion,' 'Radiant,' 'Red Barron,' 'Red Jade,' 'Red Splendor,' 'Ruby Luster,' 'Selkirk,' 'Sentinel,' 'Silver Moon,' 'Sinai Fire,' 'Camelot,' 'Prairie Maid,' 'Louisa,' 'Narrangansett,' and 'Pink Satin' sustained 50% or more leaves attacked by ATS. This level of activity was deemed aesthetically unacceptable.

For JB damage, *M. baccata* 'Jackii,' 'Jewelberry,' 'Profusion,' 'Red Jade,' 'Red Jewel,' 'Silver Moon,' 'Sugar Tyme,' *M. zumi* 'Calocarpa,' 'Sinai Fire,' 'Glen Mills,' 'Louisa,' 'Canary,' and 'Golden Raindrops' had rating averages of 1.0 or less. Unacceptable damage was found on 'Liset,' 'Radiant,' 'Red Splendor,' 'Royalty,' *M. sargentii*, 'Velvet Pillar,' 'Camelot,' and 'Candymint' which had ratings of 3.0 or more. (See Table 1. for data.)

It should be noted that the severity of damage from apple-and-thorn skeletonizer at Secrest Aboretum appears to be unusual with respect to other sites. In addition, this data is for one year only. For these reasons, the significance of this pest as a major problem on crabapples in general is questionable.

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Table 1. Summaries of Apple-and-Thorn Skeletonizer (ATS) and Japanese Beetle (JB) Adult Damage to 59 Cultivars of Crabapples at Secrest Arboretum, Wooster, Ohio, August 9, 1996.

| Crabapple | # Replicates | Average ATS±SD[a] | (LSD separation) | Average JB±SD[b] | (LSD separation) |
|---|---|---|---|---|---|
| Adams | 3 | 1.67±1.15 | JKLM | 2.33±0.58 | CDE |
| *M. baccata* Jackii | 3 | 2.67±0.58 | GHIJKLM | 0.33±0.58 | F |
| Beverly | 3 | 3.33±1.15 | FGHIJKLM | 2.33±0.58 | CDE |
| Bob White | 3 | 0.67±0.58 | M | 2.33±0.58 | CDE |
| Candied Apple | 3 | 5.00±2.65 | DEFGHIJ | 2.00±0.00 | CDE |
| Centurian | 3 | 5.67±3.21 | CDEFGH | 2.33±1.15 | CDE |
| David | 3 | 1.00±0.00 | LM | 2.00±0.00 | CDE |
| Dolgo | 3 | 5.00±1.00 | DEFGHIJ | 2.00±0.00 | CDE |
| Donald Wyman | 3 | 4.67±2.31 | EFGHIJK | 2.67±0.58 | BCD |
| M. floribunda | 3 | 5.00±0.00 | DEFGHIJ | 1.67±0.58 | DE |
| M. *halliana* Parkmanii | 3 | 3.67±0.58 | FGHIJKLM | 2.00±0.00 | CDE |
| Harvest Gold | 3 | 2.33±0.58 | HIJKLM | 1.67±0.58 | DE |
| Henningi | 3 | 4.33±3.51 | EFGHIJKL | 2.00±0.00 | CDE |
| Hopa | 3 | 3.33±0.58 | FGHIJKLM | 2.00±1.00 | CDE |
| Indian Magic | 3 | 1.33±0.58 | KLM | 1.67±0.58 | DE |
| Indian Summer | 3 | 1.00±0.00 | LM | 2.00±0.00 | CDE |
| Jewelberry | 3 | 4.00±3.61 | FGHIJKLM | 1.00±0.00 | EF |
| Liset | 3 | 2.33±0.58 | HIJKLM | 4.00±0.00 | AB |
| Mary Potter | 3 | 2.00±0.00 | IJKLM | 2.00±1.00 | CDE |
| Molten Lava | 3 | 7.67±2.08 | ABCDE | 2.00±0.00 | CDE |
| Ormiston Roy | 3 | 5.00±2.65 | DEFGHIJ | 1.67±0.58 | DE |
| Prairifire | 3 | 3.33±1.53 | FGHIJKLM | 2.00±0.00 | CDE |
| Professor Sprenger | 3 | 5.33±3.06 | DEFGHI | 2.00±0.00 | CDE |
| Profusion | 3 | 5.67±2.08 | CDEFGH | 1.33±0.58 | EF |
| Radiant | 3 | 6.00±1.00 | CDEFG | 4.33±0.58 | A |
| Ralph Shay | 3 | 4.33±0.58 | EFGHIJKL | 2.33±0.58 | CDE |
| Red Barron | 3 | 5.00±2.65 | DEFGHIJ | 2.67±0.58 | BCD |
| Red Jade | 3 | 8.33±1.15 | ABCD | 1.00±0.00 | EF |
| Red Jewel | 2 | 1.00±0.00 | LM | 1.00±0.00 | EF |
| Red Splendor | 3 | 6.00±2.65 | CDEFG | 3.00±1.00 | ABCD |
| Robinson | 3 | 1.33±0.58 | KLM | 2.33±0.58 | CDE |
| Royalty | 3 | 2.00±1.73 | IJKLM | 3.33±0.58 | ABC |
| Ruby Luster | 3 | 5.33±0.58 | DEFGHI | 2.67±1.53 | BCD |
| *M. sargentii* | 3 | 1.67±0.58 | JKLM | 3.00±0.00 | ABCD |
| Selkirk | 3 | 6.33±1.53 | BCDEF | 2.33±0.58 | CDE |
| Sentinel | 3 | 5.67±2.52 | CDEFGH | 1.67±0.58 | DE |
| Silver Moon | 3 | 6.00±2.00 | CDEFG | 1.33±0.58 | EF |
| Snowdrift | 3 | 1.00±1.00 | LM | 1.67±0.58 | DE |
| Strawberry Parfait | 3 | 1.67±1.15 | JKLM | 1.67±0.58 | DE |
| Sugar Tyme | 3 | 3.00±1.00 | FGHIJKLM | 1.33±0.58 | EF |
| Velvet Pillar | 3 | 1.33±0.58 | KLM | 3.67±0.58 | AB |
| White Angel | 3 | 4.33±2.08 | EFGHIJKL | 2.00±0.00 | CDE |
| White Cascade | 3 | 1.00±0.00 | LM | 1.67±0.58 | DE |
| Winter Gold | 3 | 4.00±1.73 | FGHIJKLM | 1.67±0.58 | DE |
| *M. zumi* Calocarpa | 2 | 2.50±0.71 | GHIJKLM | 1.00±0.00 | EF |
| Sinai Firec | 3 | 9.67±0.58 | AB | 1.00±0.00 | EF |
| Lancelot | 3 | 1.33±0.58 | KLM | 1.67±0.58 | DE |
| Adirondack | 3 | 3.67±1.53 | FGHIJKLM | 1.67±1.15 | DE |
| Camelot | 3 | 6.00±2.65 | CDEFG | 3.00±1.00 | ABCD |
| Prairie Maid | 3 | 7.67±3.21 | ABCDE | 2.67±1.15 | BCD |
| Glen Mills | 3 | 4.33±3.06 | EFGHIJKL | 1.00±0.00 | EF |
| Louisa | 3 | 10.00±0.0 | A | 1.00±0.00 | EF |

**Table 1 (Continued). Summaries of Apple-and-Thorn Skeletonizer (ATS) and Japanese Beetle (JB) Adult Damage to 59 Cultivars of Crabapples at Secrest Arboretum, Wooster, Ohio, August 9, 1996.**

| Crabapple | # Replicates | Average ATS±SD[a] (LSD separation) | | Average JB±SD[b] (LSD separation) | |
|---|---|---|---|---|---|
| Candymint | 3 | 3.67±2.52 | FGHIJKLM | 3.00±1.00 | ABCD |
| Narrangansett | 3 | 9.00±1.00 | ABC | 1.67±0.58 | DE |
| Silver Drift | 3 | 4.00±1.00 | FGHIJKLM | 1.67±0.58 | DE |
| Purple Prince | 3 | 2.33±1.15 | HIJKLM | 2.67±1.15 | BCD |
| Pink Satin | 3 | 8.33±0.58 | ABCD | 1.67±0.58 | DE |
| Canary | 3 | 3.33±0.58 | FGHIJKLM | 1.33±0.58 | EF |
| Golden Raindrops | 2 | 0.50±0.71 | M | 1.00±0.00 | EF |
| LSD value (p=0.01)[d] | | 3.65 | | 1.34 | |

[a] Average based on number of leaves with ATS damage, out of 10.
[b] Average based on visual rating of 0 to 5 where 0 = no JB skeletonizing and 5 = every leaf skeletonized.
[c] Following 14 cultivars were established in 1991.
[d] Means sharing the same LSD letters are not significantly different from each other.

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# Properties of Materials Available for Formulation of High-Quality Container Media

Harry A. J. Hoitink, Mary Ann Rose, and Randall A. Zondag

## Introduction

Successful production of containerized nursery stock requires that the growth medium is formulated from ingredients with controlled and predictable properties. Inadequate physical properties of mixes cannot be corrected during production of the crop. Therefore, all ingredients must have been sized to a reproducible particle size before formulation to avoid problems.

It is all but impossible to adjust the pH and add lime during plant growth. Therefore, chemical properties of ingredients, in terms of needs for liming or acidification, must be known. It is important that growers balance lime addition against the "alkalinity" of irrigation water. This is most critical for crops produced over a period of a year or more in containers without transplanting. Where alkalinity exceeds 100 ppm as calcium carbonate, addition of lime to mixes may not be necessary. Growers need to submit the basic mix as well as the irrigation water for analysis so that an appropriate amount of lime can be added during preparation of the mix.

Plant nutrients released by various mix ingredients must be known. Biosolids (sludge) and most manure composts, as well as yard waste composts prepared with large quantities of grass clippings, release significant amounts of micronutrients, nitrogen, phosphorous, potash, and other materials. Bark composts and peat generally do not. Bark, in fact, may immobilize nitrogen. Hardwood and some softwood bark composts release high amounts of manganese. High manganese must be corrected through addition of iron sulfate to the mix or toxicity will develop on manganese-sensitive plants. All of these properties must be taken into consideration during mix formulation.

One factor largely taken for granted by the nursery industry is the potential for natural disease suppression supported by compost-amended mixes. Although fungicides are available that control root rots, drenching over a two-year period far exceeds the cost of natural suppression. The fungicide purchase cost for materials required to treat a cubic yard of mix in pots (Subdue 2E and Cleary's 3336F) represents approximately $8.00. Most growers treat crops such as plants in the Ericaceae three to four times per year. This is a significant total cost. Thus, disease suppressive properties are very important.

This article reviews properties of materials for use in container media readily available in Ohio. A short section on mix preparation is included. For more detailed discussions of various technical aspects, consult the "Ohio certified nursery technician grower training manual."

## Sphagnum Peats

Nurserymen typically use reed-sedge or sphagnum peat. Fine, particulate peats fill in pores in

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container media, reduce air capacity, and increase the potential for root rots. For these reasons nurserymen should only use fibrous peats in container media. Reed-sedge and fine Sphagnum peats should be used as soil amendments.

Light fibrous Sphagnum peat, $H_2$ to $H_3$ on the von Post decomposition scale, harvested from the surface layers (2–4 ft. depth) in bogs, has the potential to reduce root rots. This suppressive effect lasts up to six months. This type of peat, therefore, is used most widely in floriculture. The von Post scale is described in Table 1.

Dark, more decomposed Sphagnum peat still can be fibrous. Peat producers are constantly improving peat harvesting equipment so that the fibrous nature of Sphagnum peat is destroyed as little as possible during harvesting.

The darker $H_4$ on the von Post decomposition scale level peat has high cation exchange and buffer capacities. Therefore, this type of peat is ideal for incorporation in container media because disease suppressive effects in nursery media typically are supplied by either bark or other composts.

Sphagnum peat is deficient in macronutrients as well as micronutrients. Lime, starter fertilizer, and micronutrients all must be added to peat mixes unless composts containing such nutrients are added to the mix as well.

## Pine Bark Composts

Two general types of pine barks are available to Ohio growers — red pine bark from Michigan and a mixture of five species from the Carolinas through the southeastern states to Texas. All are high in lignin and wax contents, which resist decomposition. This makes pine bark an excellent peat substitute. Growers need to select sources of pine bark that are low in wood content and of consistent quality.

Pine bark should be composted before it is used in media to improve its wettability and avoid a short period of nitrogen immobilization. It can be "aged" six to eight months in tall windrows turned periodically, or composted 10 weeks in 12-ft. tall windrows with weekly turning after amendment with 1 lb. urea per cubic yard. The bark must be kept moist (50–60% moisture) in both processes to avoid fungi from causing problems during composting and immediately after potting. Fungi that grow on dry bark form a "crust" that repels water. Mixes prepared with dry bark that is colonized by fungi are difficult to wet, and plants have problems taking up water. This type of bark also stunts plant growth for a few weeks after potting.

Composted or aged pine bark can be used in media at volumetric ratios of up to 65% and even 100%. Lime, starter fertilizer, and micro nutrients must be added to pine bark mixes unless other composts releasing these nutrients are added.

Pine barks suppress root rots, Fusarium wilts, and some nematode diseases, but not as consistently as other composts. These beneficial effects are destroyed if the mix does not drain well. It is important, therefore, to check physical properties related to drainage of the final mix.

## Composted Hardwood Barks

The wood content (total cellulose) of hardwood bark may range from as low as 50% to as high as 75%. Therefore, all hardwood barks must be composted at least six months after amendment with 3 lbs. urea per cubic yard to avoid serious nitrogen immobilization during plant growth. Spruce, Eastern hemlock, and fir bark fall in between hardwood and pine barks. Less nitrogen (1–2 lbs. urea per cubic yard) is required to avoid nitrogen immobilization in these types of barks.

Both spruce and hardwood barks release excessive quantities of manganese for some crops (not Ericaceae). Therefore, iron sulphate (1 lb. per cubic yard) must be added after composting while the compost is blended into mixes. Micronutrients typically are added to hardwood bark mixes. Hardwood bark releases more calcium than pine bark. Therefore, less lime needs to be added to mixes containing

composted hardwood bark. Again, balance lime addition against irrigation water alkalinity.

Composted hardwood bark has the best disease-suppressive properties of all composts tested so far. Growers typically add 15% by volume of a hardwood bark compost to container media used for crops particularly susceptible to Phytophthora root rots (taxus, rhododendron, and others). In the field, controlled experiments have revealed that hardwood bark mulches suppress Phytophthora collar rot of apple and Verticillium wilt of maples.

## Composted Biosolids (Sewage Sludge)

At least four municipalities in Ohio produce composted biosolids (municipal sewage sludges). Ohio now has 14 years of successful experience with these products in container media, in ground beds, and on turf. In many of these applications, composted biosolids provide superior plant growth over any other compost.

Composted biosolids are a potent source of mineralized plant nutrients. Generally, not more than 20% by volume should be added to media to avoid excessive fertility or even ammonium toxicity problems. Evergreen azaleas respond well to 10–15% composted biosolids (on a volume basis) added to mixes. Winter kill has not been observed on such plants even after the 1995 winter. The percent nitrogen in composted biosolids ranges from 1.5–2.0%. Approximately 25% of this is released in the first three months after potting. Slow release fertilizer does not need to be applied until a month or more after planting. The fines in these composts (smaller than 1/8" diameter) hold the bulk of the readily available plant nutrients. These fines produce superior fertility effects in turf and ornamentals. Disease suppressive effects observed on turf have caused it to become used more widely in recent years. Its use in container media is increasing also. Trace elements are supplied in adequate quantities at least through the first year of the crop. Lime typically does not need to be added in high alkalinity water regions.

## Composted Yard Wastes

Yard wastes generally include leaves, grass clippings, brush, and, unfortunately, also logs and tree stumps. Leaf composts generally are too fine in particle size to be utilized with consistent success in container media. They are ideal amendments for the landscape and field soil industries, however.

Grass clippings/brush composts offer ideal opportunities for use in the landscape. The salinity can be high because grass clippings mineralize almost entirely during composting. The $K_2O$ content of these composts can be as high as 1%. It is very easy, therefore, to prepare media with toxic levels of nutrients with these composts. This is avoided if low quantities (15–25%) are added to media.

Producers of composted yard wastes in Ohio are constantly improving the product quality. Composts of consistent quality are made available by some producers. Composted yard wastes with a total nitrogen content of 1.3–1.8 % do not cause nitrogen immobilization and have been used successfully in container media in several states as well as Ohio.

Wood wastes prepared from logs and stumps can be used as mulches or ground to finer particles and sold to biosolids composting plants where carbon sources are used in large quantities. This material also is "colored" with iron-containing and other dyes and utilized as mulches in mature landscape plantings. Generally, these materials are unsuitable for incorporation into container media. The total nitrogen content of these materials typically is less than 1% and, depending upon the particle size of the product, chronic nitrogen immobilization is possible.

## Composted Rice Hulls

Composted rice hulls have been used successfully in container media for at least 15 years. Fresh rice hulls contain weed seeds and plant pathogens. They are destroyed as this product composts in tall turned windrows.

Rice hulls resist decomposition because the cellulosic substances on this part of the rice plant are covered with silica as the plant grows. The shape of the hull is retained for several years in container media. Therefore, it can be used predictably in container media. At some nurseries up to 40% of the volume of the mix consists of rice hulls. The ideal volume depends on the blending ratio with other materials. In Ohio tests, 20% on a volume basis with 50–60% pine bark and the remainder (20%) as composted biosolids, hardwood bark, or composted yard wastes has provided excellent growth for a broad spectrum of species.

Composted rice hulls do not release high rates of micronutrients. Micronutrients must be added to mixes, therefore, unless composted biosolids or other composts containing these nutrients are added to the mix.

## Composted Manures

Composted manures are becoming more widely available to the green industry. Composted poultry manures may vary considerably in nitrogen concentration. Some pelletized products contain 3–4% nitrogen. These materials can be top-dressed on containers as slow-release sources of nitrogen and trace elements. In Australia, nurserymen have used this product with great success for crops such as foliage plants. Some sources of composted poultry manure contain as little as 2% nitrogen. These materials can be blended with container media with great success as long as the concentration of available nutrients is taken into consideration.

Composted cow manure is much lower in nitrogen (1–2%) content than poultry manure. It typically cannot be incorporated into container media at rates higher than 15% on a volume basis because of the high small particles content and the potential high salts content.

Composted hog manures are now becoming available. In general, all manures release adequate quantities of trace elements. Biological control of soil-borne disease typically is associated with incorporation of these compost types in container media.

## Blending Process

The first step is to settle on the ingredients to be blended into a mix and to determine (1) the physical properties related to drainage (air capacity) and water retention and (2) chemical amendment needs. Be certain to pay attention to salinity. As mentioned previously, lime addition must be based on irrigation water analysis and records at a particular location.

The physical properties of a mix cannot be predicted from an analysis of the ingredients. The final mix must be analyzed for drainage, air capacity, and water retention before it is used in the nursery. The air capacity of media used in nursery containers should exceed 20% for most crops and 25% for crops sensitive to Phytophthora root rots.

Because the particle size of various pine barks, hardwood bark composts, composted rice hulls, and sludge composts differs from source to source, it would be unwise to provide ideal blending ratios of ingredients in this paper. It is possible to state, however, that materials containing small amounts of fines (particles <1 mm diameter) generally yield ideal physical properties. Furthermore, highly biodegradable ingredients (composted hardwood barks, biosolids, manures) should not be used at incorporation rates over 15–20%.

Adding enough water during blending to raise the moisture content of the organic fraction in the mix to 50% (weight basis) is critical. Furthermore, the blended mix should not be stored in large piles in a closed bin. Mixes stored in large piles ferment, particularly if stored in bins where air exchange from all sides into the base of the pile is limited. Such fermented (sour) mixes cause significant problems (root injury) immediately after potting. This often results in stunted growth for woody plants for weeks thereafter. Air must be able to "draft" freely up through the mix. The temperature in the mix should remain below 45°C. Height and width of piles should be reduced if this temperature is exceeded. Low temperatures (less than 40°C) allow beneficial microorganisms to colonize the mix and avoid root injury immediately after planting.

Concrete mixers, although they blend well, should not be used because it takes too long to load and unload such systems. This causes unnecessary grinding of particles, generation of fines, and destruction of desirable physical properties of the final mix.

Slow release fertilizers should not be added to a mix if it is to be stored for a long period (a week or more) before potting. An exception is urea formaldehyde, which often is added at a very low rate (1–2 lbs. per cubic yard), to offset nitrogen immobilization observed in bark mixes early during production.

We recommend that growers consult the *Ohio Certified Nursery Technician Grower Training Manual,* K. D. Cochran, Editor, for details on standards of chemical and physical properties of container media. (The manual is available from ONLA, 2021 E. Dublin-Granville Rd., Suite 185, Columbus, OH 43229.)

**Table 1. Modified Version of the von Post Scale for Assessing the Degree of Decomposition of Fresh Peat and Peat Dried for Horticultural Use.**

| Degree of Decomposition | Nature of Water Expressed on Squeezing | Proportion of Peat Extruded Between Fingers | Nature of Plant Residues | Description |
|---|---|---|---|---|
| H1 | Clear, colorless | None | Unaltered, fibrous, elastic | Undecomposed |
| H2 | Almost clear, yellow-brown | None | Almost unaltered | Almost undecomposed |
| H3 | Slightly turbid, brown | None | Most remains easily identifiable | Very slightly decomposed |
| H4 | Turbid, brown | None | Most remains identifiable | Slightly decomposed |
| H5 | Strongly turbid, contains a little peat in suspension | Very little | Bulk of remains difficult to identify | Moderately well decomposed |
| H6 | Muddy, much peat in suspension | One third | Bulk of remains unidentifiable | Well decomposed |
| H7 | Strongly muddy | One half | Relatively few remains identifiable | Strongly decomposed |
| H8 | Thick mud, little free water | Two thirds | Only resistant roots, fibers, and bark | Very strongly decomposed |
| H9 | No free water | Almost all | Practically no identifiable remains | Almost completely decomposed |
| H10 | No free water | All | Completely amorphous | Completely decomposed |

[1] **Reference:** Puustjarvi, V. and R. A. Robertson. 1975. Physical and Chemical Properties. P. 23-30. In: Peat in Horticulture. S. W. Robinson and J. G. D. Lamb, Eds. Academic Press. Inc., London. 170 p.

# Composted Biosolids: An Ideal Organic Amendment for Container Media Supplying Both Nutrients and Natural Suppression of Root Rots

Harry A. J. Hoitink, Mary Ann Rose, and Randall A. Zondag

The nursery industry has used composted biosolids beneficially since the late 1970s (Hoitink, 1994). When this product first became available, it was incorporated in media at excessively high volumetric ratios, ranging from 20–60%. Many plant species produced in such mixes responded well (Logan et al., 1984). However, some plant types suffered from "salt" injury (Hoitink and Maronek, 1986), a direct result of the high rate of nutrients released by composted biosolids. High nitrogen diseases also were increased. On the other hand, Rhizoctonia and Pythium root rots were suppressed in media amended with composted biosolids (Kuter et al., 1988).

During 1994, 1995, and 1996, the utilization of composted biosolids in nursery media was revisited. This was done through a series of demonstration trials at various growers in Ohio with plant species differing in fertility needs and susceptibility to root rots. This paper reports the results of such trials and projects the best utilization strategies for composted biosolids in container media.

## Materials and Methods

Composted biosolids (Technagro™) produced at the City of Akron composting facility were received from Kurtz Bros., Inc., Independence, Ohio. Three container media were tested at several growers and compared with the standard mix at each location.

The media contained (on a volume basis):
1. 10% Technagro (Tec), 20% composted rice hulls (CRH), 60% aged pine bark (APB), and 10% silica sand (SS);
2. 15% Tec, 20% CRH, 55% APB, 10% SS; and
3. 20% Tec, 20% CRH, 50% APB, and 10% SS.

Therefore, the pH of these mixes ranged from 5.8 to 6.1 and lime was not added. The conductivity of the mixes ranged from 1.8 to 2.2 mS, which is ideal. All other nutrients, including trace elements, were available at optimum concentrations.

Composted biosolids (Tec) release nitrogen, phosphorus, and potash for several weeks after potting and in quantities adequate for growth of most species if incorporated at 20% (v/v). Therefore, slow release fertilizer was not added to containers until four weeks after potting. The air-filled pore space after saturation and drainage in two-gallon containers for all three mixes ranged from 25–30%, which also is within the ideal range for most crops.

Plants were transplanted as quart-size liners into two-gallon containers in May 1995, irrigated as needed, and treated with standard fertility treatments used for each crop at each grower, except that fertilizer was not added until four weeks after potting. All plants were irrigated under the same system because

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physical properties related to drainage were similar for all mixes. Marketability, plant growth, and root rot severity for each crop was monitored for 17 months after potting.

## Results

At all locations, most plants produced in the Tec mixes grew significantly (P=0.05) faster than those in the grower control mixes. Data in Tables 1 and 2 present more details for each of the crops. Evergreen azaleas tested at two growers responded well in all Tec mixes. Winterkill was not observed by either grower producing azaleas in the 20% Tec mix, even during the 1995–96 winter. However, during August 1996, Pythium root rot was evident on azalea in the 20% Tec mix, in the lowest two inches of the container. Azaleas in the 10% and 15% Tec mixes were free of root rot at all times.

*Cornus alba* 'Elegantissima,' *Ligustrum* x *vicaryi* 'Golden Privet,' and *Spiraea* x *bumalda* 'Gold Flame' also responded positively to all Tec amendment rates. In November 1995, at the completion of the first growing season, a significant number of plants of each of these crops was marketable (Table 1). In August 1996, most of these plants were larger than optimum for a two-gallon container crop.

*Juniperus conferta* 'Blue Pacific' responded well in the Tec mixes, although moderate and severe root rot was observed on these plants in the 15% and 20% Tec mixes, at the end of the 1995 growing season. Root rot severity in the 10% Tec mix was mild and not different from that in the grower mix (aged pine bark, composted hardwood bark, peat , sand). During the spring of 1996 (second growing season), roots of this juniper crop in all mixes were free of rot. In summary, Pythium root rot was observed on *Juniperus conferta* 'Blue Pacific' during the first six months after potting in the 20% Tec mix in particular, and plants recovered thereafter.

Blue hollies responded well in all three Tec mixes at two growers where this crop was tested. Stems were thicker and leaves larger and plants were more vigorous than those in the control mixes (aged pine bark, sphagnum peat, sand mix). Thielaviopsis black root rot was not observed on blue hollies in the Tec mixes. Controlled inoculations will need to be performed, to establish whether these mixes indeed suppress root rot caused by *Thielaviopsis basicola*.

*Cotoneaster* responded positively to all three composted biosolids amendment rates (10, 15, and 20%). Fire blight problems were encountered on this crop in trials in the early 1980s with 20% and higher rates of composted biosolids (40 and 60%). In these trials, fire blight did not present problems, probably because slow release fertilizer was not added at the time of potting.

In summary, all plant species responded positively to the 10% Tec amendment rate. Most responded positively to the 15% Tec amendment. Only *Fothergilla gardenii* and *Juniperus conferta* 'Blue Pacific' grew less rapidly in the first year in the 15% and 20% Tec mixes, but both recovered thereafter. In conclusion, composted biosolids incorporated at 10% and 15% on a volumetric basis in container media provided excellent growth and produced high-quality plants. For heavy feeders, the 20% rate provided even better results.

A 1994 publication summarizing 20 years of research and demonstration trials with composted biosolids in the United States (Clapp et al., 1994) concluded that this resource can provide fertility and many other beneficial effects. In our demonstration (1994 through 1996) trials, similar observations were made. The low incorporation rates utilized in these trials provided adequate concentrations of trace elements for a two-year crop. In addition, growers did not have to add lime. The pH of the mixes remained near 6.0 after 17 months of production.

Major nutrients (N, P, K), supplied by the compost during the first four to six weeks after potting, allow growers to apply slow release fertilizer after the crop has developed a canopy. The pellets therefore can be placed in the shade under plants, preventing excessive release rates associated with slow release pellets positioned in the open sun on pots (130°F), often resulting in ammonia toxicity on young plants (Inbar et al., 1990).

In early (1978–1983) trials with composted biosolids at nurseries in Ohio (Hoitink and Maronek, 1986; Logan et al., 1984), increases in the severity of high-nitrogen induced diseases, such as fire blight of pyracantha and Phytophthora dieback of rhododendron, were observed. In these 1994–96 trials at the lower rates (10–20%), evidence for increased disease severity or excessive fertility was not obtained. Such conditions probably would have developed in the 20% mix had growers applied slow release fertilizer at the time of potting, thus providing excessively high fertility conditions and susceptibility to these foliar diseases.

The high pH of 6.0 observed in the composted biosolids-amended mixes did not result in iron deficiency on any crops tested. Even at pH 7.4 in high carbonate water regions in Ohio, iron deficiency is avoided on many crops in composted biosolids-amended mixes (Hoitink and Maronek, 1986). In bark mixes, problems would occur at that pH. Today, explanations for this "greening" effect of composted biosolids are being found. Chen et al., 1996, showed that the concentrations of dissolved micronutrients can be increased by amending mixes with composted biosolids. The soil microflora supported by these composts produces siderophores, which chelate micro nutrients such as iron, thus making it available to plants. In conclusion, composted biosolids contribute beneficial effects to the nursery industry through several mechanisms.

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**Table 1. Marketability of Woody Ornamentals After Seven Months (1-10-95) and 17 Months (8-96) of Production in Container Media Amended with Various Rates of Composted Biosolids. (Technagro ™).**

| Technagro Rate (%, v/v) | Rhododendron 'Cascade' (Cascade Azalea) | | *Cornus alba* 'Elegantissima' | | *Fothergilla gardenii* | | *Juniperus conferta* 'Blue Pacific' | | *Ligustrum x vicaryi* | | *Spiraea x bumalda* 'Goldflame' | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10/95 | 8/96 | 10/95 | 8/96 | 10/95 | 8/96 | 10/95 | 8/96 | 10/95 | 8/96 | 10/95 | 8/96 |
| 0[1] | 4.0[2] | — | 4.0 | — | 2.2 | — | — | — | 4.0 | — | 2.8 | — |
| 10 | 2.6 | 1.2 | 2.4 | 1.0 | 2.2 | 1.0 | 1.8 | 1.0 | 2.4 | 1.0 | 1.4 | 1.0 |
| 15 | 1.8 | 1.0 | 1.8 | 1.0 | 2.0 | 1.0 | 1.8 | 1.0 | 1.8 | 1.0 | 1.8 | 1.0 |
| 20 | 2.0 | 1.4 | 2.6 | 1.0 | — | — | 2.0 | 1.0 | 2.6 | 1.0 | 2.2 | 1.0 |
| $LSD_{005}$ | 0.7 | — | 0.8 | — | 0.9 | — | 1.1 | — | 0.8 | — | 1.0 | — |

[1] Grower control mix containing aged pine bark, composted hardwood bark, peat, and sand.
[2] Mean marketability rating based on five ratings of 10 replicates per species: 1 = best, 4 = worst quality.

**Table 2. Root Rot Severity and Growth Rating of Woody Ornamentals Produced Seven Months in Container Media Amended With Various Rates of Composted Biosolids.**

| Technagro Rate (%, v/v) | Rhododendron 'Cascade' (Cascade Azalea) | | *Fothergilla gardenii* | | *Juniperus conferta* 'Blue Pacific' | | *Ligustrum x vicaryi* | | *Spiraea x bumalda* 'Goldflame' | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RR[2] | Growth[3] | RR | Growth | RR | Growth | RR | Growth | RR | Growth |
| 0[1] | 1.2 | 13.1 | 2.7 | 17.8 | 1.2 | — | 1.0 | 11.8 | 1.0 | 17.5 |
| 10 | 1.1 | 16.6 | 2.6 | 19.9 | 1.5 | — | 1.0 | 14.6 | 1.0 | 21.0 |
| 15 | 1.3 | 15.8 | 4.5 | 18.1 | 3.8 | — | 1.0 | 17.1 | 1.0 | 21.2 |
| 20 | 1.2 | 15.5 | — | — | 5.1 | — | 1.1 | 17.2 | 1.0 | 21.7 |
| $LSD_{005}$ | 0.4 | 1.4 | 0.6 | 1.9 | 0.8 | — | 0.1 | 0.1 | — | 1.6 |

[1] Grower control mix containing aged pine bark, composted hardwood bark, peat, and sand.
[2] Mean root rot severity of 10 replicates based on a severity scale in which 1 = symptomless, 2 = mild root rot (1–5 root tips), 3 = mild to moderate root rot (5–20 rotted roots), 4 = moderate root rot (1/3 root ball rotted), 5 = severe root rot (>1/3 root ball rotted), 6 = severe root rot and crown rot, and 7 = dead plant.
[3] Mean plant growth rating of 10 replicates per treatment based on total plant height (h) and one width (no) measurement.

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# Composted Biosolids II: Trials on The Ohio State University Campus

Mary Ann Rose, Harry A. J. Hoitink, and Randall Zondag

## Summary

Four woody ornamentals were grown in three media containing composted biosolids at 10%, 15%, or 20% volume. Plant heights, diameters, and overall appearance were satisfactory in all. treatments. The growth of the four species of woody ornmanentals was judged to be excellent and essentially equivalent in all three growing media. Increasing the fraction of the compost from 10% to 20% increased growing medium pH by as much as one pH unit. While roots appeared to be disease-free in the fall of 1995 and the spring of 1996, it was apparent that root growth was inhibited in all media one to two inches from the bottom of the pot. Root growth was vigorous and unrestricted throughout the rest of the container.

## Introduction

This work is a companion study to another reported in this circular by Hoitink, Rose, and Zondag. The objective of both studies was to evaluate three different potting mixes containing varying proportions of Technagro™ (TG), a composted municipal sludge product produced from the city of Akron composting facility. This study reports results from trials on the Ohio State University Columbus Campus. Other trials were carried out at commercial nurseries and are reported in "Composted Biosolids: An Ideal Organic Amendment for Container Media Supplying Both Nutrients and Natural Suppression of Root Rots."

Mary Ann Rose, Department of Horticulture and Crop Science; Harry A. J. Hoitink, Department of Plant Pathology, Ohio Agricultural Research and Development Center; Randall A. Zondag, Ohio State University Extension, Lake County

## Materials and Methods

The three mixes used in this study were the same as described by Hoitink et al.

- 10% by volume, all TG screened to 1/2" or less before addition (with fines).
- 15% TG by volume, half of the material with fines, half of the material sized between 1/2" and 1/8" (coarse).
- 20% TG by volume, all material sized between 1/2" to 1/8" (all coarse).

Thus, as the proportion of TG in the mixes increased, the proportion of fines decreased.

Four commonly grown species of woody ornamentals were potted in the three media on May 25, 1996. Quart-size *Cotoneaster dammeria* 'Lowfast' and *Juniperus chienensis* 'Hetzii Glauca' were potted into two-gallon containers; three-year *Taxus x media* 'Densiformis' bed liners were potted into two-gallon containers, and 6–8" rooted cuttings of *Ligustrum x vicaryl* were potted into one-gallon containers. Fifteen plants of each treatment were arranged in a randomized complete block design in the container holding area at Ohio State. Irrigation was supplied by overhead sprinklers. All containers were top-dressed with slow-release fertilizer (Osmocote 18-6-12) at a 2 lbs. nitrogen (N) per cubic yard rate on June 16. Occasionally, plants were pruned lightly in accordance with normal nursery practice.

Height and plant diameters were taken on July 12, August 17, and October 16. Growing medium samples were taken from all pots on July

6 (*Taxus* and *Juniperus*) or August 24 (*Cotoneaster* and *Ligustrum*). At final harvest (October 16), three soil balls from each treatment and replication (nine per treatment, total) were cut in half and the roots examined. Growing medium samples were taken from these pots. All medium samples were analyzed using the saturated media extract procedure. Soil extracts were tested for pH, soluble salts, and nitrate-nitrogen. Six plants from each treatment remained for observation in spring of 1966.

Data were analyzed using SAS statistical procedures. In Tables 1 and 2, statistical differences between treatments are indicated by the letters a, b, c. Where no letters appear, there were no differences in treatment.

# Results and Discussion

### Plant Growth Measurements

For all three dates, there was little difference in plant height and diameter among the three media treatments (Table 1). The only statistical difference noted between treatments was in the *Ligustrum* (Privet). On July 12, the 15% and 20% treatments produced somewhat more growth than the 10% medium; however, there were no differences in the later measurements. General observations of plant appearance and quality also suggested that growth was quite satisfactory in all three media. By the end of the season, juniper and cotoneaster plants had reached saleable size and were of marketable quality. *Taxus* and *Ligustrum* quality was satisfactory, but these plants had not yet reached marketable dimensions for their pot size.

### Growing Media Analyses

An increase in pH was the most consistent effect that increasing TG had on the nutritional characteristics of the growing media. Increasing TG from 10% to 15% increased medium pH by as much as one full unit (Table 2). There was, however, little difference between pH values in the 15% and 20% TG media, which suggests that the fines fraction may contribute more to increasing pH. (The 20% TG treatment contained coarse TG only, no fines.)

Since pH is a critical factor in controlling nutrient availability in a growing medium, this may be a key consideration in formulating a future medium. A desirable pH range for container media is 5.5–6.5; the pH of the 15% and 20% TG media usually exceeded this range (Table 2). However, the plants chosen for this study are fairly tolerant of a wide range in pH values and did not appear to exhibit any response to differences in media pH.

In contrast to the pH data, the soluble salts (EC) and nitrate-N data were quite variable (Table 2). Although there were some statistical differences among treatments for some dates for *Taxus* and *Cotoneaster,* the differences were not great and the pattern not consistent. Overall, soluble salts and nitrate levels were in an acceptable range, with a few exceptions. *Cotoneaster,* the most vigorous plant, not surprisingly had the lowest nitrate concentrations in the media. *Ligustrum,* in contrast, had quite high nitrate and EC readings in August. These plants were quite small when planted, and root systems did not completely fill the pots until later in the season. Higher nitrate and soluble salt levels in the *Ligustrum* media probably reflect proportionately less uptake relative to the three larger, rapidly growing species. Only the *Ligustrum* media analysis revealed some potentially problematic levels of nitrates. While *Ligustrum* was unharmed by these levels, salt sensitive plants could be affected. The high nitrate levels in the *Ligustrum* media could have resulted from the compost or the slow-release fertilizer.

### Observations of Roots, October 1995, May 1996

Roots in all three compost media were numerous and healthy in appearance, but in nearly all cases, roots were sparse or absent from the bottom one to two inches of medium. This bottom layer typically was saturated, and apparently the aeration was not sufficient for root growth. Several of the same species of plants were growing nearby in compost-free media; roots readily grew into the bottom of the medium in those media.

Among the three media, the 10% TRG appeared to have a slight edge over the 15% and 20% media in terms of numbers of roots in the juniper, *Cotoneaster,* and *Ligustrum.* However, the difference was not great and was not reflected in top growth. Furthermore, these visual root observations were subjective and not quantitative.

In May 1966, roots of the three compost treatments were examined once more. No signs of root rot were observed in any of the treatments.

**Table 1. Average Plant Height and Diameters of Four Genera on Three Dates.**

| | Plant Heights (cm) | | | Plant Diameters (cm) | | |
|---|---|---|---|---|---|---|
| | July 12 | Aug 17 | Oct 16 | July 12 | Aug 17 | Oct 16 |
| *Cotoneaster* | | | | | | |
| 10% | 32 | 23 | 39 | 43 | 56 | 59 |
| 15% | 30 | 24 | 38 | 48 | 54 | 60 |
| 20% | 27 | 23 | 40 | 45 | 55 | 61 |
| Juniper | | | | | | |
| 10% | 30 | 33 | 38 | 45 | 56 | 60 |
| 15% | 32 | 34 | 38 | 43 | 54 | 59 |
| 29% | 31 | 33 | 40 | 45 | 56 | 61 |
| *Ligustrum* | | | | | | |
| 10% | 17a | 26 | 39 | 16a | 27 | 36 |
| 15% | 20b | 28 | 36 | 19b | 27 | 35 |
| 20% | 22b | 27 | 39 | 20b | 27 | 35 |
| *Taxus* | | | | | | |
| 10% | 39 | 41 | 43 | 34 | 33 | 32 |
| 15% | 38 | 39 | 40 | 35 | 34 | 33 |
| 20% | 39 | 40 | 41 | 35 | 34 | 33 |

Statistically significant differences between treatments are indicated by letters a, b, c. Where no letters appear, there were no differences between treatments.

Table 2. Growing Media pH, EC, and Nitrate Levels for Four Genera, Two Dates.

| | pH | | EC (mS) | | Nitrate | |
|---|---|---|---|---|---|---|
| | Aug 24 | Oct 19 | Aug 24 | Oct 19 | Aug 24 | Oct 19 |
| *Cotoneaster* | | | | | | |
| 10% | 5.4a | 5.8a | 0.93 | 0.97 | 24a | 30 |
| 15% | 6.7c | 7.0b | 0.77 | 0.97 | 8b | 11 |
| 20% | 6.4b | 6.8b | 0.83 | 0.73 | 13ab | 10 |
| Juniper | | | | | | |
| 10% | 5.8a | 5.7a | 0.90 | 0.97 | 64 | 25 |
| 15% | 6.7b | 6.7b | 0.72 | 0.81 | 42 | 30 |
| 20% | 6.6b | 6.7b | 0.71 | 0.90 | 38 | 41 |
| *Ligustrum* | | | | | | |
| 10% | 5.4a | 6.0a | 1.00 | 0.68 | 68 | 30 |
| 15% | 6.2b | 6.9b | 1.85 | 0.53 | 172 | 20 |
| 20% | 6.1b | 6.9b | 1.83 | 0.73 | 166 | 26 |
| *Taxus* | | | | | | |
| 15% | 5.6a | 6.6 | 0.95a | 0.59a | 80a | 37 |
| 15% | 6.7c | 7.1 | 0.66b | 0.88b | 32b | 62 |
| 20% | 6.5b | 6.8 | 0.81ab | 0.82b | 53b | 69 |

Statistically significant differences between treatments are indicated by letters a, b, c. Where no letters appear, there were no differences between treatments.

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# Paclobutrazol/Paint Mix on the Inside Surface of Plug Cells to Control Plug Height

Claudio C. Pasian and Daniel K. Struve

## Summary

The effectiveness of applying a plant-growth regulator as a paint/paclobutrazol mixture coating the interior surface of plug cells was evaluated. Three bedding plant species (Marigold, *Tagetes patula* cv. 'Bonanza Spray;' Impatiens, *Impatiens wallerana* cv. 'Blitz White;' and Salvia, *Salvia splendens* cv. 'Little Tango') were grown in 288 plug trays (24 rows, 12 cells per row) in sections three rows wide with the interior surface of each cell covered by flat latex paint with paclobutrazol concentrations of 0, 12.5, 25, 50, 100, and 200 mg $l^{-1}$ (0, 0.00125, 0.0025, 0.005, 0.01, and 0.02 mg a.i. per cell respectively).

Significant reductions in impatiens and marigold plug height were observed at paclobutrazol concentrations as low as 12.5 mg $l^{-1}$ while 50 mg $l^{-1}$ paclobutrazol was required before a reduction in salvia plug height was observed. Plugs subjected to growth regulator treatments were greener than the control plants. No signs of phytotoxicity were attributed to either paclobutrazol or the paint. These results suggest that the application of paclobutrazol and paint to the interior of plugs may represent the development of a new practical method of systemic growth regulator application. Chemical name used: β-((4-chlorophenyl) methyl)-α-(1,1-dimethyl)-1H-1,2,4,-triazole-1-ethanol (paclobutrazol).

## Introduction

The use of plant growth regulators in plug production is important for crops that stretch soon after plant emergence. This tendency is compounded by plant crowding in a plug tray. Overlapping of plant parts reduces light intensity and changes light quality, resulting in light below plant canopies that is richer in near-infrared and far-red which encourages plant stretching. As a consequence, the application of growth regulators to control plug height is a common practice among plug producers. While drenching is the most effective method of application for some growth regulators (e.g., paclobutrazol), it is impractical for plugs. As a result, spraying is the most common application method for plug production.

The concept of using copper-coated interior containers to control root growth was introduced in the 1970s. Roots containing copper-treated surfaces absorb high amounts of copper (Arnold and Struve, 1989). Pasian and Struve (1996) showed that plant growth regulators, like copper, could be delivered using coated interior containers. They demonstrated that chrysanthemum, *Dendranthema grandiflora*, plant height could be controlled using containers with the internal surface coated with a paint/paclobutrazol mixture. The objective of this study was to determine the response of three bedding plant species to paclobutrazol/paint mix applied on the interior plug cell surface.

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## Materials and Methods

Paclobutrazol was stirred into a white interior flat latex paint (water solution of butyl acrylate/vinyl acetate copolymer, titanium dioxide, aluminum silicate, and amorphous silicate). After mixing the paint and paclobutrazol for 15 minutes, the mix (0.1 ml) was brushed uniformly onto the internal surface of plastic plug tray cells. After painting, the cells were dried for 24 hours before use.

Plug trays (288 cells: 24 rows, 12 cells per row) were cut in sections three rows wide. Of the three rows of a section, two had the cells painted with the paint/paclobutrazol mix, and then were filled with growing medium and seeded. Plug tray sections were divided into seven treatments — control (no paint and no paclobutrazol), paint only (paint with no paclobutrazol), and five paint/paclobutrazol mixes applied at rates 12.5, 25, 50, 100, and 200 mg $l^{-1}$ (1.25, 2.5, 5, 10, and 20 µg a.i. per cell, respectively). Seeds of marigold (*Tagetes patula*, cv. 'Bonanza Spray'), impatiens (*Impatiens wallerana*, cv. 'Blitz White'), and salvia (*Salvia splendens*, cv. 'Little Tango') were sown by hand in the plug tray sections. The cells were filled with a mix of 82% (by volume) sphagnum peat moss, 18% perlite, and a wetting agent (Greenway 18% Seedling Mix, KLX Growers LTD, Ontario, Canada). Seeds were covered lightly with horticultural grade vermiculite.

After sowing, the seeded plug tray sections were watered with tap water and placed inside an illuminated germination chamber at 21 C. Seedling emergence for marigold and salvia was determined after seven days and after 17 days for impatiens. The plug tray sections were then moved to a greenhouse and the seedlings watered as needed for three days. From then on, tap water was alternated with a 20N-8.7P-16.7K fertilizer solution at a rate of 100 mg $l^{-1}$ N. After 31 days, plug height (the distance between the rim of the plug cell and the top of the plug) was measured for marigolds and salvias, and after 38 days, for impatiens.

Rate response to paclobutrazol was determined by regression analysis using the GLM procedure of SAS (SAS Inst. Cary, NC). Single-degree-of-freedom contrasts were used to compare the control and the lowest effective concentration of paclobutrazol in paint.

## Results and Discussion

Paint and/or plant growth regulator did not negatively affect seedling emergence of impatiens and salvia (Table 1). More work is required to validate the reduction in marigold seedling emergence. No signs of phytotoxicity were attributed to paint. Plugs subjected to paclobutrazol were significantly shorter and greener than control plants. There was no significant difference in plant height between marigold and salvia plugs for the control and paint-only treatments. These results are consistent with those found by Pasian and Struve (1996) with chrysanthemum plants grown in 485 ml plastic containers. However, impatiens plants in the paint-only treatment were significantly shorter than the control plants (Fig. 1).

Increasing paclobutrazol concentrations produced shorter plugs (Table 2). Concentrations of 200 mg $l^{-1}$ reduced plug heights 51% for impatiens, 42% for marigold, and 43% for salvia. Pasian and Struve (1996) found that increasing paclobutrazol concentrations in paint from 100 mg $l^{-1}$ to 150 and 200 mg $l^{-1}$ did not produce shorter chrysanthemum plants. In the present study, however, higher concentrations of paclobutrazol in paint yielded shorter plugs. One explanation for this finding may be the greater root length:container surface ratio of a plant grown in a plug tray, which allows greater root contact with the walls than a plant in a 485 ml container; hence, the plant absorbs proportionally more growth regulator. More research is required to study the effect of the paint/growth regulator mix on root length density and root distribution inside plugs.

Growth regulator concentrations as low as 12.5 mg $l^{-1}$ reduced impatiens and marigold plug height (17% and 11% of controls respectively). In salvia, the lowest concentration of paclobutrazol in paint that produced a substantial reduction in plug height was 50 mg $l^{-1}$. It is unknown why salvia plugs in the 100 mg $l^{-1}$ treatment were taller than plugs in the 50 mg $l^{-1}$ treatment (Fig. 1).

The paint application method is potentially a better method than drench or spray growth regulator treatments. The growth regulator is fixed in paint, and workers are less exposed to it because they do not contact the chemicals coating the plug cells' internal surface. This application technique may be advantageous in light of the increasing stringency on restricted entry intervals of the Worker Protection Standards. As opposed to drenches and sprays, the paint application method may release less growth regulator chemical into the environment. Additional studies are being conducted to determine any environmental impact of this growth regulator application technique. The results obtained with impatiens, marigold, and salvia must also be validated with other plug crops. However, until this method of application is described on the label of commercial growth regulators, it cannot be used by bedding plant growers.

## Acknowledgments

Appreciation is expressed to Uniroyal Chemical for its financial support.

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Pasian, C.C. and D.K. Struve. 1996. A New method of application of paclobutrazol to potted plants. HortScience, 31(4) 655.

**Table 1. Percentage Seedling Emergence for Impatiens, Marigold, and Salvia at Five Different Concentrations of Paclobutrazol.**

| | % Germination | | | | | | |
|---|---|---|---|---|---|---|---|
| Crop | Control | Paint only | 12.5 mg $l^{-1}$ | 25 mg $l^{-1}$ | 50 mg $l^{-1}$ | 100 mg $l^{-1}$ | 200 mg $l^{-1}$ |
| **Impatiens** | 65 | 83 | 86 | 83 | 83 | 79 | 65 |
| **Marigold** | 100 | 80 | 96 | 96 | 96 | 86 | 92 |
| **Salvia** | 75 | 70 | 75 | 83 | 62 | 75 | 75 |

Table 2. Level of Significance of Two Contrasts (Control vs. 25 mg $l^{-1}$ and 50 mg $l^{-1}$) and Two Models (linear and quadratic) for Impatiens, Marigold, and Salvia at Five Different Concentrations of Paclobutrazol.

| | Significance | | |
|---|---|---|---|
| Contrast | Impatiens | Marigold | Salvia |
| Control vs. 25 mg $l^{-1}$ | ** | ** | -- |
| Control vs. 50 mg $l^{-1}$ | -- | -- | ** |
| Linear model | ** | NS | * |
| Quadratic model | ** | ** | NS |

* = Significant, ** = Highly significant, NS = Nonsignificant

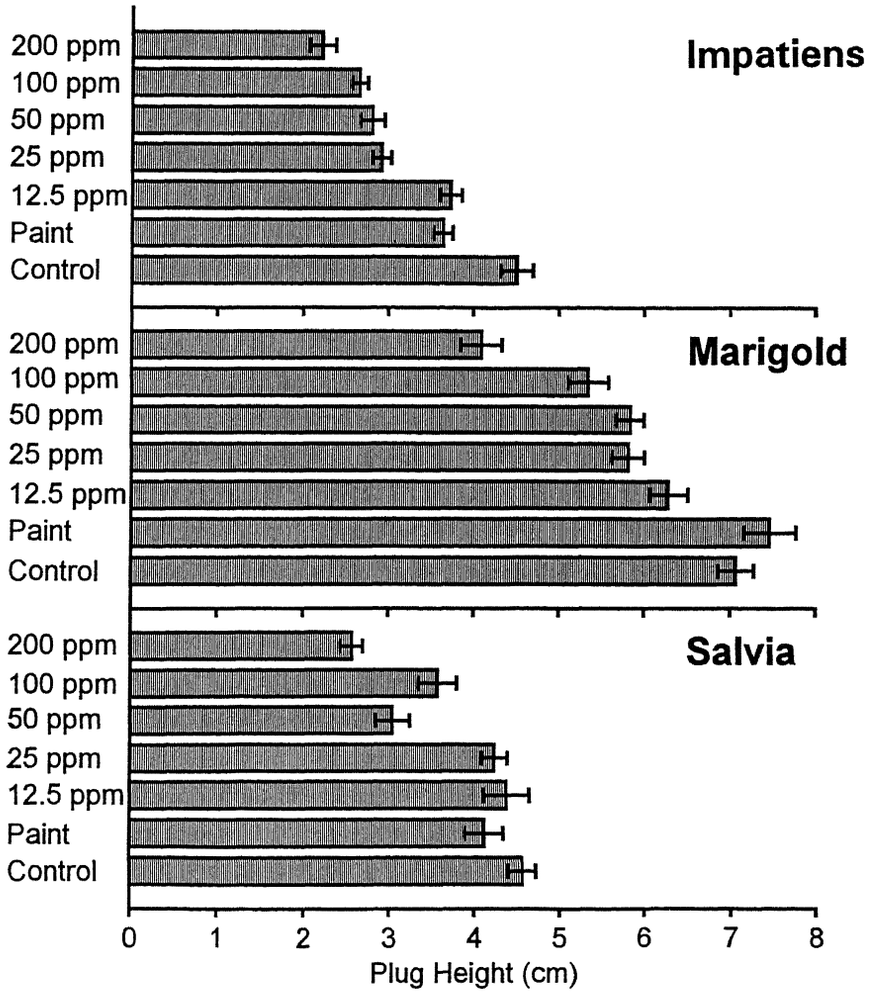


Figure 1. Plug heights (cm) of impatiens, marigold, and salvia seedlings grown in plug cells coated on interior surface with paclobutrazol/paint mixes at five different growth regulator concentrations. Horizontal bars represent SE.

# Urban Foresters Will Need 20,000 Trees for the Year 2000

T. Davis Sydnor and Daniel K. Struve

## Summary

There continues to be a real need for increased diversity in urban tree populations to counter the threat of massive losses of over-planted species, such as occurred when Dutch elm disease struck the American elm. Insect and disease sprays are rarely an option for most urban foresters in today's political climate. Reasons for the limited numbers of species are identified.

A survey of 27 urban foresters in Ohio was conducted to identify potential demand for nursery stock for planting in the year 2000 and beyond. Survey results were shared with the nursery industry by publishing the results in the August 1996 Educational Update in *The Buckeye*. Results of the survey are being shared with urban foresters so that they might know which plants are being requested and might be available for inclusion on a bid list.

We hope to assist nursery production planning by identifying which of the 127 species and cultivars on the survey form are likely to be requested by urban foresters. Plants likely to be in less demand have been identified as well. Some trees that have been requested are ones that producers might not be growing. The needs identified in the survey might encourage producers to grow some new plants and enable urban foresters to increase biological diversity in the urbanscape.

## Introduction

A survey was conducted to identify the needs of Ohio's cities and towns for the year 2000 and to enhance the diversity of species being planted along Ohio's streets and highways. Akron's recent street tree inventory identified 58% of the treelawn trees as *Acer* while University Heights had 45% *Acer*. Both cities felt the need to diversify but expressed concern over the difficulty in obtaining less commonly grown trees needed to accomplish the task. We feel that these two comments are representative of the feeling of urban foresters in Ohio's cities and towns.

Common guidelines used to foster biological diversity are:

1. No more than 5% of the trees should be in the same species;

   Or:

2. No more than 10% of the trees should be in the same species, no more than 20% in the same genus, and no more than 30% in the same family (the 10-20-30 Rule).

We endorse the 10-20-30 rule as a benchmark against which to measure the diversity of the urban forest. Based on Akron and University Heights inventories, it is easy to conclude that there is a real need to diversify.

The difficulty in obtaining "unusual" species is easy to confirm and exists for a variety of reasons. For the nursery manager, a common statement is: "No one ever asked for that before." This statement is often used to rationalize the fact that nursery producers feel that they

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cannot produce a tree for which they do not have an established market. We can all agree that just growing a tree is a risk. There has to be a market for the product. Hopefully, this paper will help the nursery industry to identify potential markets for uncommon trees which they may not be growing at the present time.

## Materials and Methods

Urban foresters were given a paper describing 31 less commonly grown trees. These were trees that had either been raised through the Ohio Production System, or trees that the authors felt had strong potential for use in urban areas. These 31 trees are listed in Table 1 with their common name in bold type. The survey also included more commonly grown trees.

Urban foresters were asked to provide the following information:

- Name and address.
- The size of plants you would normally purchase and an estimate of the total number of trees you expect to plant in the year 2000.
- An estimate of the number of plants of each type you might wish to purchase in the year 2000 for planting in your community.

Forms were then returned to Dr. T. Davis Sydnor, The Ohio State University, 210 Kottman Hall, 2021 Coffey Road, Columbus, OH 43210-1085 for tabulation.

## Results and Discussion

The cities of Akron, Bellefontaine, Bexley, Cincinnati, Cleveland, Cleveland Heights, Columbus, Dayton, Dublin, Elyria, Garfield Heights, Grove City, Lakewood, Maple Heights, Medina, Mount Vernon, Sandusky, Springfield, Toledo, University Heights, Upper Arlington, Westlake, and Worthington as well as the villages of Granville, Leetonia, Mount Gilead, and Terrace Park responded to the survey. A total of 19,700 trees were requested and expected to be planted in the year 2000. Table 1 lists all 127 species and cultivars on the survey form and how many plants were requested of each. Trees with few or no requests were also included. Knowing which species had low demand is as important to a producer as knowing which were in high demand.

There were 31 frequently requested species in 23 different genera. Of the species with 200 or more requests, only the *Acer, Fraxinus,* and *Quercus* genera included more than one species (Table 1). Of the eight species of *Acer* that were heavily requested, four (*Freemanii, platanoides, rubrum,* and *saccharum*) have been commonly grown in Ohio while four (*buergerianum, campestre, ginnala,* and *griseum*) are less commonly grown. *Fraxinus* contained two commonly and one less commonly grown species in the commonly requested species list. *Quercus* contained two species, both of which are grown by Ohio growers.

Other heavily requested species included *Amelanchier x grandiflora, Carpinus betulus, Celtis reticulata, Corylus colurna, Eucommia ulmoides, Ginkgo biloba, Gleditsia triacanthos, Halesia caroliniana, Koelreuteria paniculata, Malus x cultivars, Ostrya virginiana, Platanus x acerifolia, Pyrus calleryana, Syringa reticulata, Tilia cordata, Ulmus parviflora,* and *Zelkova serrata.* Only *Celtis reticulata* is not listed in the *Ohio Nursery Stock Survey* as published by the Ohio Nursery and Landscape Association. The netted hackberry has a particular appeal for urban foresters since it is alkaline soil tolerant and has a mature height of less than 30 feet, which allows it to be grown under power lines for 30 years without pruning for line clearance. Both characteristics are desirable for urban sites.

An interesting result of the survey was the popularity of various genera (summarized in Table 2). There were 3,363 requests for maples of various types which made *Acer* the most requested genera. This is consistent with maple's current popularity and not unexpected. *Fraxinus* was requested 1,488 times. *Amelanchier* and *Tilia* were requested 1,144 and 979 times, respectively. *Gleditsia, Pyrus,* and *Ulmus* were re-

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Anyone still interested in participating in the survey should contact Dr. Sydnor, who will maintain a modified survey list for reference.

quested more than 700 times each. *Syringa* has been increasing in popularity in recent years and was requested almost 600 times.

The second most requested genera was *Quercus* with 1,769 requests. This is surprising since only two oak species appeared in the most requested species list. Eleven oak species were requested moderately (55–256 requests). Oaks have performed well in urban situations since they have been long-lived and relatively free of serious pests. It is interesting to speculate on the impact of gypsy moth feeding on oak performance in urban areas. Gypsy moth is now established in Ohio. Based on the experience of the eastern United States where the gypsy moth has long been established, oaks will not lose their popularity and will remain serviceable, if properly sited.

Nurseries often find that oaks are less desirable from their perspective, since they may require more time to produce salable plants and lack the marketing advantages of clones. Clones have not been as popular with urban foresters as they are with the general public. Urban foresters are more concerned with service life and maintenance costs than they are with aesthetic characteristics such as fall color and flower color, which are often the basis for clonal selection and marketing.

One thing to remember with oaks is that they are seedling grown. Seed source is important when a plant has a large geographic range. Also, in an urban environment, plants may be grown at the environmental equivalent of the northern or western edge of the species' range. Sawtooth, red, and shumard oaks must be from northern seed sources to ensure that the seedlings are cold hardy. Pin oak must be from local seed sources to ensure tolerance to Ohio's neutral to alkaline soils. Seedlings from parent trees, which appear to have been native near McMinnville, Tennessee, have been prone to iron deficiency while seedlings from native Ohio pin oaks have shown high resistance to this problem. Ohio's best producers can use seed sources as a marketing tool if they maintain records.

*Ulmus* is another surprisingly popular genus with 777 requests. When asked at a recent meeting to predict the most popular genera during the early part of the next century, Davis Sydnor predicted an increase in elm popularity. Perhaps people believe the prediction, but we hope that urban professionals remember that elms were a monoculture in the 1920s. Their extreme tolerance to the stresses associated with urban sites resulted in overplanting early in this century. Elms are no less urban tolerant today than they were 70 years ago. There are many sites where urban tolerance outweighs sensitivity to Dutch elm disease (DED).

The key in proper plant selection is to maximize assets while minimizing liabilities. A disease-sensitive American elm would probably last for five years longer than green ash in a truly urban site. Thus the health of the urban forest would be improved, even if the trees eventually died from DED. Of course, DED-resistant American elms are now available and should receive preference for planting in the 1990s.

A number of trees were not requested by urban foresters. Boxelder, sugar maple seedlings, European bird cherry, Chinese chestnut, and Russian olive received no requests at all. Fewer than 30 requests were received for 11 species where specifying named cultivars was not an option. These included redbud, pagoda dogwood, flowering dogwood, Washington hawthorn, star magnolia, white mulberry, wild black cherry, black locust, European mountain ash, David elm, and Wilson's elm. The reasons for the lack of popularity of these plants were not specifically stated, but likely results from poor service life, overplanting, lack of familiarity with the species, or extreme site specificity.

The seedling versus clone debate has been an interesting one. While the survey was not designed to look at this issue directly, some information emerged and is worth noting. Freeman maple, red maple, silver maple, sugar maple, white ash, and green ash clones were heavily requested while the seedlings had less than 30 requests. This might be expected since the clones of these plants are among the most heavily promoted, and the aesthetic advantages are obviously of interest to urban foresters. Surprisingly, seedlings were requested more

than clones for sweetgum, American linden, and littleleaf linden. Aesthetic differences between seedlings and clones are less pronounced for these plants and may account for the result.

One omission in the survey was osage orange. The survey should have noted thornless male selections rather than the seedlings which appeared. Perhaps clones would have been requested more, as fruit and thorns are real problems for the seedlings in urban areas. Thornless male clones such as 'White Sword' and 'Wichita' will allow us to take advantage of the environmental tolerance and moderate size of osage orange while avoiding its liabilities.

Cities are not the only customers for production nurseries. Urban foresters may be more discriminating and more concerned with serviceability than the general public. Still, nurseries may want to consider the popularity or lack of popularity for these plants with cities when deciding on future production planning for these plants.

Another concern of producers is that they prefer plants that are easy to produce profitably. The Ohio State University is concerned about this as are commercial producers. Current research programs focus on alternative production techniques for less commonly grown trees.

American Electric Power's (AEP) Smart Tree program is funding Dr. Struve's investigation on production techniques and performance of uncommon trees for urban use. AEP is particularly interested in trees that could be used under power lines with reduced pruning and thus reduced line-clearing costs. Still, AEP understands that growers must know how to profitably grow a tree in order for that tree to be produced for sale and planted in the urban landscape. Thus, AEP has funded production research.

Trees with scientific names appearing in bold type in Table 1 have been tried in the Ohio Production System (OPS). Results to date have been variable. Most plants respond with vigorous growth, shaving years from traditional production cycles, while other plants perform no better in the OPS system than under standard field production techniques.

This paper has dealt with a variety of issues that have been shared with us over the years. Neither urban foresters nor nursery producers are aware of some of the unusual species that could be grown. Ohio's urban foresters believe that they must increase species diversity. Less common species are difficult to find and purchase. Nurseries need to reduce production risks by growing trees that are in demand. A special need exists for trees that can be grown beneath power lines for 30 or more years without heavy pruning.

Urban foresters, nursery producers, landscape architects, landscape contractors, and utility companies must all understand the need for increased diversity and remain committed to the task. The real truth is that all of us want an improved quality of life; this is especially important for 80% of Ohio's population, as these people live and work in towns and cities of more than 30,000 people.

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Participants were told that the survey results would be shared with the nursery industry in an attempt to encourage production of the requested species. The year 2000 was chosen to allow nursery producers enough lead time for the industry to begin to produce the plants for sale.

**Table 1. The Numbers of Plants Requested by 27 Urban Foresters for Planting in the Year 2000.**

The trees are listed alphabetically by species and cultivar. The total number of requested trees is 19,700. Plants whose scientific name is in bold type have been grown in the Ohio Production System. Plants whose common name is in bold type were discussed in the diversity paper given to the urban foresters before they filled in the form.

| Expected Need | Scientific Name | Common Name | Family |
|---|---|---|---|
| 360 | **Acer buergerianum** | trident maple | Maple |
| 603 | Acer campestre | hedge maple | Maple |
| 0 | Acer x Freemanii (seedlings) | **Freeman maple** | Maple |
| 254 | Acer x Freemanii CULTIVARS | Freeman maple selections | Maple |
| 268 | **Acer ginnala** | amur maple | Maple |
| 343 | Acer griseum | **paperbark maple** | Maple |
| 0 | Acer negundo | boxelder | Maple |
| 72 | Acer palmatum | Japanese maple | Maple |
| 10 | Acer platanoides | Norway maple (seedling) | Maple |
| 426 | Acer platanoides CULTIVARS | Norway maple selections | Maple |
| 95 | **Acer rubrum** | red maple | Maple |
| 456 | **Acer rubrum CULTIVARS** | red maple selections | Maple |
| 20 | **Acer saccharinum** | silver maple | Maple |
| 59 | Acer saccharinum CULTIVARS | silver maple selections | Maple |
| 0 | Acer saccharum | sugar maple | Maple |
| 272 | Acer saccharum CULTIVARS | sugar maple selections | Maple |
| 125 | Acer saccharum nigrum | black maple | Maple |
| 38 | **Aesculus glabra** | Ohio buckeye | Horsechestnut |
| 125 | **Aesculus octandra** | yellow buckeye | Horsechestnut |
| 100 | Alnus cordata | Italian alder | Birch |
| 120 | **Alnus glutinosa** | European alder | Birch |
| 1144 | Amelanchier grandiflora | **serviceberry** | Rose |
| 41 | **Asimina triloba** | **pawpaw** | Custard Apple |
| 70 | Betula nigra | river birch | Birch |
| 94 | Betula nigra CULTIVARS | river birch selections | Birch |
| 210 | **Carpinus betulus** | European hornbeam | Birch |
| 276 | Carpinus betulus CULTIVARS | European hornbeam selections | Birch |
| 62 | **Carya cordiformis** | **bitternut hickory** | Walnut |
| 0 | **Castanea mollissima** | Chinese chestnut | Beech |
| 55 | Celtis laevigata | sugar hackberry | Elm |
| 82 | Celtis occidentalis | American hackberry | Elm |
| 258 | **Celtis reticulata** | **netted hackberry** | Elm |
| 180 | Cercidiphyllum japonicum | Japanese katsura | Katsura |
| 27 | **Cercis canadensis** | Eastern redbud | Pea |
| 172 | Chionanthus retusus | **Oriental fringetree** | Olive |
| 25 | Cornus controversa | pagoda dogwood | Dogwood |
| 60 | **Cornus drummondi** | **drummond grey dogwood** | Dogwood |
| 9 | Cornus florida | flowering dogwood | Dogwood |
| 105 | Cornus kousa | kousa dogwood (Northern seed source) | Dogwood |
| 138 | **Cornus mas** | corneliancherry dogwood | Dogwood |
| 318 | **Corylus colurna** | Turkish filbert | Birch |
| 10 | Crataegus phaenopyrum | Washington hawthorn | Rose |

Table 1 (Continued). The Numbers of Plants Requested by 27 Urban Foresters for Planting in the Year 2000.

| Expected Need | Scientific Name | Common Name | Family |
|---|---|---|---|
| 232 | Crataegus crus-galli 'inermis' | thornless cockspur hawthorn | Rose |
| 90 | Crataegus punctata 'Ohio Pioneer' | Ohio pioneer dotted hawthorn | Rose |
| 112 | Crataegus viridis 'Winter King' | **winter king green hawthorn** | Rose |
| 30 | Diospyros virginiana | **common persimmon** | Ebony |
| 0 | Elaeagnus angustifolia | Russian-olive | Oleaster |
| 194 | Eucommia ulmoides | **hardy rubbertree** | Eucommia |
| 180 | Evodia daniellii | **Korean evodia** | Rue |
| 80 | Fagus sylvatica | European beech | Beech |
| 55 | Fraxinus americana | white ash | Olive |
| 462 | F. americana CULTIVARS | white ash selections | Olive |
| 80 | Fraxinus excelsior | European sh | Olive |
| 25 | F. pennsylvanica | green ash | Olive |
| 549 | F. pennsylvanica CULTIVARS | green ash selections | Olive |
| 317 | Fraxinus quadrangulata | **blue ash** | Olive |
| 344 | Ginkgo biloba | **ginkgo** | Ginkgo |
| 145 | Gleditsia triacanthos | honeylocust | Pea |
| 623 | Gleditsia triacanthos CULTIVARS | thornless honeylocust selections | Pea |
| 140 | Gymnocladus dioicus | Kentucky coffeetree | Pea |
| 245 | Halesia carolina | Carolina silverbell | Storax |
| 383 | Koelreuteria paniculata | **golden raintree** (cold hardy source) | Soapberry |
| 161 | Liquidambar styraciflua | sweetgum(cold hardy source) | Witch hazel |
| 26 | Liquidambar styraciflua CULTIVARS | sweetgum (hardy selections) | Witch hazel |
| 40 | Liriodendron tulipifera | tulip poplar | Magnolia |
| 30 | Maclura pomifera | osage orange (thornless males) | Mulberry |
| 92 | Magnolia acuminata subcordata | **yellow cucumbertree magnolia** | Magnolia |
| 47 | Magnolia x Loebneri | loebner magnolia | Magnolia |
| 40 | Magnolia x Soulangeana | saucer magnolia | Magnolia |
| 5 | Magnolia stellata | star magnolia | Magnolia |
| 70 | Malus species | **crabapples** | Rose |
| 604 | Malus x CULTIVARS | disease resistant crabapples | Rose |
| 88 | Metasequoia glyptostroboides | dawnredwood | Yew |
| 5 | Morus alba | white mulberry | Mulberry |
| 224 | Nyssa sylvatica | blackgum | Tupelo |
| 378 | Ostrya virginiana | American hophornbeam | Birch |
| 120 | Phellodendron amurense | amur corktreee | Rue |
| 251 | Platanus x acerifolia | London planetree | Sycamore |
| 50 | Platanus occidentalis | sycamore | Sycamore |

Table 1 (Continued). The Numbers of Plants Requested by 27 Urban Foresters for Planting in the Year 2000.

| Expected Need | Scientific Name | Common Name | Family |
|---|---|---|---|
| 0 | Prunus padus | European bird cherry | Rose |
| 210 | Prunus sargentii | sargent cherry | Rose |
| 15 | Prunus serotina | wild black cherry | Rose |
| 150 | Prunus serrulata | Oriental cherry | Rose |
| 59 | Ptelea trifoliata | **waferash** | Rue |
| 35 | Pterocarya fraxinifolia | **caucausian wingnut** | Walnut |
| 30 | Pteroceltis tartarinowii | **tartar wingedceltis** | Elm |
| 80 | Pyrus calleryana | callery pear (seedling) | Rose |
| 620 | Pyrus calleryana CULTIVARS | **callery pear** selections | Rose |
| 175 | Quercus acutissima | **sawtooth oak** (cold hardy seed source) | Beech |
| 156 | Quercus alba | white oak | Beech |
| 188 | Quercus bicolor | **swamp white oak** | Beech |
| 208 | Quercus coccinea | scarlet oak | Beech |
| 256 | Quercus imbricaria | shingle oak | Beech |
| 86 | Quercus macrocarpa | bur oak | Beech |
| 155 | Quercus muehlenbergii | **Chinquapin oak** | Beech |
| 64 | Quercus palustris | pin oak (local seed source) | Beech |
| 160 | Quercus robur | English oak | Beech |
| 55 | Quercus robur 'Fastigiata' | upright English oak | Beech |
| 111 | Quercus rubra | red oak (cold hardy seed source) | Beech |
| 150 | Quercus shumardii | shumard oak (cold hardy seed source) | Beech |
| 10 | Robinia pseudocacia | black locust | Pea |
| 125 | Sassafrass albidum | **sassafrass** | Laurel |
| 98 | Sophora japonica | **Japanese pagodatree**(cold hardy source) | Pea |
| 5 | Sorbus aucuparia | European mountainash | Rose |
| 597 | Syringa reticulata | Japanese tree lilac | Olive |
| 143 | Taxodiuim distichum | baldcypress | Yew |
| 80 | Tilia americana | basswood | Linden |
| 115 | Tilia americana CULTIVARS | American linden selections | Linden |
| 388 | Tilia cordata | little-leaf linden | Linden |
| 140 | Tilia cordata CULTIVARS | little-leaf linden selections | Linden |
| 30 | Tilia mongolica | **Mongolian linden** | Linden |
| 85 | Tilia tomentosa | **silver linden** | Linden |
| 161 | Tilia tomentosa CULTIVARS | silver linden selections | Linden |
| 120 | Ulmus x CULTIVARS | hybrid elm selections | Elm |
| 159 | Ulmus americana CULTIVARS | disease resistant American elm | Elm |
| 15 | Ulmus davidiana | **David elm** | Elm |
| 443 | Ulmus parvifolia | lacebark elm | Elm |
| 20 | Ulmus wilsoniana | **Wilson elm** | Elm |
| 142 | Viburnum lentago | **nannyberry** | Honeysuckle |
| 67 | Zelkova serrata | Japanese zelkova | Elm |
| 220 | Zelkova serrata CULTIVARS | Japanese zelkova selections | Elm |

Table 2. Requests by Genera Where More Than One Taxa Is Listed in Table 1 or Where the Genus Comprised 1% or More of the 19,700 Total Requests.

| Genera | Common Name | Number | Percentage |
|---|---|---|---|
| Acer | maple | 3363 | 17.1 |
| Aesculus | buckeye | 163 | 0.8 |
| Alnus | alder | 220 | 1.1 |
| Amelanchier | serviceberry | 1144 | 5.8 |
| Betula | birch | 164 | 0.8 |
| Carpinus | hornbeam | 486 | 2.5 |
| Celtis | hackberry | 395 | 2.0 |
| Cornus | dogwood | 337 | 1.7 |
| Corylus | hazlenut | 318 | 1.6 |
| Crataegus | hawthorn | 444 | 2.3 |
| Eucommia | hardy rubbertree | 194 | 1.0 |
| Fraxinus | ash | 1488 | 7.6 |
| Ginkgo | ginkgo | 344 | 1.7 |
| Gleditsia | honeylocust | 768 | 3.9 |
| Halesia | silverbell | 245 | 1.2 |
| Koelreuteria | golden raintree | 383 | 1.9 |
| Liquidambar | sweetgum | 182 | 0.9 |
| Magnolia | magnolia | 179 | 0.9 |
| Malus | crabapple | 674 | 3.4 |
| Nyssa | blackgum | 224 | 1.1 |
| Ostrya | hophornbeam | 328 | 1.7 |
| Platanus | planetree | 301 | 1.5 |
| Prunus | cherry | 375 | 1.9 |
| Pyrus | pear | 700 | 3.6 |
| Quercus | oak | 1769 | 9.0 |
| Syringa | lilac | 597 | 3.0 |
| Tilia | linden | 999 | 5.1 |
| Ulmus | elm | 777 | 3.9 |
| Zelkova | zelkova | 287 | 1.5 |
| Total of Frequently Requested Trees | | 17,848 | 90.6 |

# Abstracts

## Seasonal Patterns of Nitrogen Use in Three Woody Ornamentals

Barbara Biernacka and
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Department of Horticulture and Crop Science, The Ohio State University. 1996. HortScience 31(4):673.

Seasonal patterns of N uptake and allocation in *Buxus microphylla*, *Acer x freemanii*, and *Fothergilla gardenii* were investigated for improving fertilization strategies. Rooted cuttings were planted in 3.5 liter containers May 25, 1995. Plants were drip-irrigated on an as-needed basis with 50, 100, or 200 $mg{\cdot}N{\cdot}l^{-1}$ solutions. Leaves, stems, and roots were destructively harvested every six weeks, starting June 24. Net changes in dry weight and N uptake were determined for each of six periods throughout the first growing season and twice in the second season after growth began.

Dry weights of *Acer* increased with N rate in the first year, but in the second year, there was no difference on the new flush of growth (dry weight) between the 100 and 100 $mg{\cdot}N{\cdot}l^{-1}$ treatments, for any species. The 200 $mg{\cdot}N{\cdot}l^{-1}$ rate caused severe injury to *Fothergilla*.

N uptake of the deciduous species increased in the first three periods, with greatest N uptake between September and October. Greatest N uptake in *Buxus* occurred between July and September. Increasing the N fertilization rate increased tissue N concentration in all species. Total N content in *Buxus* increased between October and December with a large proportion of N appearing to shift from leaf to stem tissue. In the other species, leaf abscission caused a net reduction in whole-plant N contents in the 100 and 200 $mg{\cdot}N{\cdot}l^{-1}$ rates between October and December, although stem and root N contents increased. Increasing the N fertilization rate in *Acer* delayed fall coloration but hastened leaf abscission.

End-of-experiment N recovery (nitrogen taken up / N applied) was extremely low, and decreased with increasing rate of N. *Acer* in June 1996 recovered 3.0%, 2.7%, and 1.1% of total N applied for low, medium, and high fertilizer rates. *Buxus* recovery was even lower (2.6%, 1.0%, 1.0%, for 50, 100 and 200 $mg{\cdot}N{\cdot}l^{-1}$ respectively).

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## Why Do Roses Die: How Can We Make Them Last Longer?

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Roses are among the most attractive and the most short-lived cut flowers. We have all been disappointed by the fading and shriveling of petals after a few days. At this point the flower is losing more water than it takes up through the stem, but why should this occur? Among the simpler possibilities are:

- The permeability to water increases in cell membranes in the petals
- The rose uses up its food reserves; when the sugar runs out it has no more energy to maintain cellular organization.
- The rate of production or sensitivity to ethylene increases and this triggers cellular changes
- Bacteria accumulate in the vase solution and

these block the xylem so that water uptake becomes impossible.

An undergraduate class in postharvest physiology was asked to test these hypotheses through a number of experiments. They also reviewed the extensive literature on roses as cut flowers. One can question whether it is necessary to know why roses die in order to improve their vase-life. As in many other areas of applied plant science, practical improvements have been achieved by a purely empirical approach. Plant physiologists then try to explain why these treatments are effective. Floral preservatives have been developed by screening formulations of sugar and inhibitors of microbial growth. The students ran all of their experiments with roses in water and in a commercial preservative to see whether they could relate the effects of preservative to any of the hypotheses. Further experiments have involved a number of commercially available preservatives.

Data obtained by the students indicated that shriveling of the petals and development of "bent-neck" were associated with physiological changes in the flower itself, rather than blockage of the stem by bacteria. Ethylene treatment promoted these changes, and the changes could be delayed by treatment with inhibitors of ethylene synthesis or action.

Additional information can be found on the World Wide Web at http://hortwww-2.ag.ohio-state.edu/hvp/rose/rose1.htm.

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# Development of a National On-Line Interactive Database of Internship Opportunities for Students of Horticultural Science

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Internships are becoming an increasingly used mechanism of providing undergraduates with experience in their chosen profession before job placement, and potential employers view internships favorably in making hiring decisions. Many horticulture programs require internships as part of their curricula, while others are considering the option.

Because internship opportunities in horticulture have been compiled in a wide variety of discipline-specific resources with no central, inclusive "clearinghouse," students often overlook potential opportunities, particularly those outside of their home state, leaving some industry members without interns.

The internet-based database of internships developed jointly by Virginia Tech and Ohio State will be discussed within the context of being a resource for all horticulture programs. Other schools will be shown how to contribute to and to use the database so its national scope can be fully used and expanded.

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# Copper Sulfate Filters Influence Photoperiodic Response But Not Post-Production Longevity of Chrysanthemum "Spears"

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John W. Kelly

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"Spears" of chrysanthemums grown under solar filters filled with $CuSO_4$ solution or water were exposed to natural and artificial long and short days. Plants that flowered were evaluated for postharvest performance. Internode length and/or plant height was reduced under $CuSO_4$ filters compared to controls, regardless of photoperiod.

Plants grown under control filters and receiving natural long days flowered 10 days after plants grown in the same photoperiod under $CuSO_4$ filters, and 17 days after plants grown under control or $CuSO_4$ filters that received artificial short days. Although plants grown under $CuSO_4$ filters and receiving long days flowered seven days after control- or $CuSO_4$-filter grown plants receiving short days, the number of nodes was the same for all treatments indicating flower induction occurred simultaneously. Plants under both filters flowered at the same time during natural short days. A fluorescent light night break prevented or delayed flowering of plants grown under control and $CuSO_4$ filters during natural short days.

Leaf chlorophyl increased when plants were grown under $CuSO_4$ filters and were subjected to natural long days, natural short days, or artificial short days compared to plants grown under clear filters and subjected to respective photoperiods. Plants grown under $CuSO_4$ filters and subjected to a night break did not exhibit increased chlorophyll levels compared to plants that were grown under clear filters and received a night break. Postproduction quality was not affected by filter.

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# Influence of Spectral Filters on Growth of *Euphorbia pulcherrima* 'Glory'

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John W. Kelly

Department of Horticulture, Clemson University

Plants of poinsettia (*Euphorbia pulcherrima*) 'Glory' were grown in chambers fitted with double-walled polycarbonate panels filled with light-filtering solutions of a blue dye, 6% (w:v), CuSO4, or water (control) that altered the ratio of R to FR to 1.00, 3.30, and 1.16, respectively. Plants grown under $CuSO_4$-filters were shorter (32%) with shorter internodes (48%) than control plants. Leaf chlorophyll was 56% greater in CuSO4-grown plants compared to control.

Plants from all treatments flowered at the same time when placed in the chambers during photoperiods inductive for flowering (short day) (year one). Plants flowered two weeks earlier under CuSO4 filters compared to controls when placed in the chambers during non-inductive photoperiods (year two). Informal postproduction evaluations of plants showed no differences in the rate of senescence of plants from any treatment.

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# Publishing Newsletters on the World Wide Web Using Database Software

Tim Rhodus

Department of Horticulture and Crop Science, The Ohio State University. 1996. HortScience 31(4):588.

Preparing newsletters for distribution over the World Wide Web generally requires one to learn HTML (hypertext markup language), purchase an HTML editor, or convert existing word-processing documents through a utility program.

As an alternative, an input form was developed for county agents that facilitates the direct publishing of their weekly Buckeye Yard and Garden On-line newsletter over the Internet. Using FileMaker Pro 3.0 for Macintosh and the ROFM acgi script for WebSTAR, agents cut and paste text from their word processing file into specific input boxes on the screen and then submit it to the server located in Columbus. Their newsletter articles are then made available to anyone on the Web through a searchable database that allows for searching by date or title.

Preparation of the input form and corresponding search form creates two distinct advantages: county agents do not have to spend time learning about HTML coding, and all their newsletters are indexed in a searchable database with no additional effort by the site manager. Modification of this procedure has been done to facilitate the creation of online term projects for students and a directory for horticultural internships.

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# Red Thread Management Study — Kentucky Bluegrass

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**Methods**

A red thread (*Laetisaria fuciformis*) study was initiated on May 29, 1996 at the TruGreen-ChemLawn Research and Development Center, Delaware, Ohio, on a four-year-old stand of Kentucky bluegrass (*Poa pratensis*) consisting of 'Julia,' 'Merit,' 'Schamrock,' and 'Touchdown' at 25% each. The soil is Blount silt loam, with a pH of 6.2. The turfgrass was maintained at two-inch cutting height, with clippings returned, and irrigated as needed to avoid water stress. The condition of the stand was fair with good color and medium density.

Liquid treatments were made with a $CO_2$ small plot sprayer with nozzle tips 8004 operating at 40 psi (2.5 gallons/1,000 sq. ft.). Dry treatments were made by hand. The plots measured 6 x 10 ft. and were replicated three times in a randomized complete block design. Spring conditions in Delaware were unusually wet and cool. Red thread was very active. A single application was made of the treatments.

**Results**

Readings of the number of patches of red thread were taken at approximately two and three weeks after application. Outstanding control was achieved with Heritage and ProStar. Sentinel shows excellent results over time; however, initial control was slow. Chipco 26019 WDG and 2F both demonstrate good management of this disease. Daconil demonstrated good short-term reduction of the disease, but since this material is a contact fungicide, repeat applications would be needed. The fertilizer applications that were done were not adquate this year to manage the disease.

**Table 1. Red Thread Management in Kentucky Bluegrass**

| Treatment/Product | Rate Oz./1,000 Sq. Ft. | Number of Red Thread Patches per Pilot 6/12 | 6/20 |
|---|---|---|---|
| Heritage 50 WG | 0.4 | 0.7 | 0.0 |
| Heritage 50 WG + Chipco WDG | 0.4 + 2.0 | 0.7 | 0.3 |
| Heritage 50 WG | 0.2 | 1.3 | 0.3 |
| Prostar 50 WP | 7.4 | 2.3 | 0.3 |
| IB 11924 | 2.75 | 2.7 | 3.3 |
| Chipco 26019 WDG | 2.0 | 4.0 | 4.3 |
| Chipco 26019 2F | 4.0 | 4.7 | 4.0 |
| Lynx 25 DF | 0.75 | 6.0 | 3.0 |
| Sentinel 40 WG + Daconil Ultrex 82.5 WDG | 0.25 + 2.0 | 6.3 | 1.3 |
| Banner Maxx 14.3 | 1.0 | 6.3 | 13.3 |
| Fertilizer (18-5-9) | 1 lb. of N | 8.0 | 15.3 |
| Daconil Ultrex 82.5 WDG | 3.8 | 8.7 | 30.7 |
| Eagle 40 WP | 1.2 | 11.3 | 24.7 |
| Sentinel 40 WG | 0.25 | 11.7 | 2.0 |
| Bayleton 50 WG | 0.5 | 14.0 | 9.0 |
| Bayleton 1.0 G | 3 lbs. | 25.7 | 27.7 |
| Scotts FFII 15.4 PCNB + 14-3-3 | 29.18 lbs./5.5M | 32.7 | 20.0 |
| Control | | 38.3 | 54.0 |
| LSD (0.05) | | 12.7 | 20.3 |

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# Red Thread Management Study — Perennial Ryegrass

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## Methods

A red thread (*Laetisaria fuciformis*) study was initiated on May 18, 1996, at The Ohio State University Turfgrass Research Center, Columbus, Ohio. The turfgrass was an established stand of perennial ryegrass (*Lolium perenne*), cultivar unknown, maintained at 2.5 inches with clippings removed. The soil was a clay with a pH of 7.3. The area received minimal maintenance with no fertilization or irrigation during the past year. The condition of the stand was fair with poor color and rather low density. No thatch was present. Liquid treatments were made with a $CO_2$ small plot sprayer with nozzle tips 8004 operating at 40 psi (2.5 gallons/1,000 sq. ft.). Dry treatments were made by hand. The plots measured 6 x 10 ft. and were replicated three times in a randomized complete block design. At the time of application, the disease was active, and 30–40% of the surface of each plot was diseased. Spring conditions in Columbus were unusually wet and cool. Red thread was active at the time of applications.

## Discussion

Initial reduction in red thread was most evident with Heritage and Prostar. Other materials that

Table 1. Red Thread Management in Perennial Ryegrass

| Treatment/Product | Rate Oz./1,000 Sq.Ft. | Percent Red Thread* 6/5 (3 WAT)** | 6/12 (4 WAT) |
|---|---|---|---|
| Heritage 50 WP + Primo | 0.4 + 0.2 | 5.0 | 6.7 |
| Prostar 50 WP | 7.4 | 5.7 | 5.0 |
| Heritage 50 WG | 0.2 | 11.7 | 6.7 |
| Heritage 50 WG | 0.4 | 11.7 | 5.3 |
| Lynx 25 DF | 0.75 | 13.3 | 8.3 |
| Heritage 50 WG | 0.14 | 14.0 | 10.0 |
| Chipco 50 WDG | 2.0 | 15.0 | 21.7 |
| Sentinel 40 WG | 0.25 | 15.0 | 6.7 |
| IB 11924 | 2.75 | 16.7 | 15.0 |
| Daconil ZN | 6.0 | 16.7 | 23.3 |
| Lynx 25 WG | 1.0 | 18.3 | 13.3 |
| Thalonil 90 DF | 3.5 | 20.0 | 18.3 |
| Bayleton 50 WG | 0.5 | 20.0 | 12.3 |
| Daconil Ultrex 82.5 WDG | 3.8 | 20.0 | 18.3 |
| Chipco 26019 2F | 4.0 | 21.7 | 10.0 |
| Eagle 40 WP | 1.2 | 25.0 | 25.0 |
| Banner Maxx | 1.0 | 26.7 | 20.0 |
| Lynx 25 DF | 0.5 | 29.0 | 13.3 |
| Banner Maxx + Primo | 2.0 + 0.3 | 30.0 | 18.3 |
| Fertilizer (18-5-9) | 1 lb. N/1,000 sq.ft. | 40.0 | 23.3 |
| Urea (46-0-0) | 1 lb. N/1,000 sq.ft. | 40.0 | 26.7 |
| Primo | 0.3 | 55.0 | 43.3 |
| Control | | 61.7 | 55.0 |
| LSD (0.05) | | 20.4 | 13.4 |

* Ratings indicate a percent infection on a scale from 0–100% with 100 being equal to complete coverage of the plot by the disease.

** WAT = weeks after treatment.

showed an initial reduction included Lynx, Chipco 26019 WDG, Sentinel, and the chlorothalonil products. Primo treatments initially had no effect on red thread activity. However, by the end of the study, considerable disease was present in the Primo plots. The likely reason was the reduction in turfgrass growth from the application of Primo (a plant growth regulator).

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# Nutrient Uptake Patterns in Forsythia

Hao Wang and Mary Ann Rose

Department of Horticulture and Crop Science, The Ohio State University. 1996. HortScience 31(4):674.

Nutrient uptake and allocation patterns of *Forsythia ovata* x *Europaea* 'Meadowlark' grown in a recirculating hydroponic system were observed for five months in the greenhouse. Dormant rooted cuttings were placed in the system on May 8, 1995. The nutrient solution supplied, in mg.l-1, 100 N, 48 P, 210 K, 30 Mg, 70 Ca, 117 SO4, 3 Fe, 0.5 Mn, 0.15 Zn, 0.15 Cu, 0.5 B, 0.1 Mo. Solutions were completely replaced every two weeks. Leaves, stems, and roots were harvested for dry weight and nutrient analysis at monthly intervals.

Nitrogen uptake and dry weight accumulation in the roots increased throughout the experiment, reaching a maximum in the fifth month (September). Nitrogen uptake and dry weight accumulation of leaves and stems increased rapidly throughout the first three months, then leveled off.

Whole-plant N recovery (N taken up/N in hydroponics system) reached a maximum (58%) between July 6 and August 3. N recovery in the hydroponics system was about 10 times greater than what was observed in related experiments with woody plants in typical production environments, suggesting that there is potential for manipulating fertilization and cultural practices to increase fertilization efficiency in woody ornamentals.

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